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UNITED STATES AIR FORCE  
ARMSTRONG LABORATORY

+GZ IMPACT TESTS OF THE LARGE  
JPATS MANIKIN IN A SIMULATED  
MARTIN-BAKER EJECTION SEAT

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FOR THE COMMANDER



THOMAS J. MOORE, Chief  
Biodynamics and Biocommunications Division  
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## PREFACE

The impact tests and data analysis described in this report were accomplished by the Escape and Impact Protection Branch, Biodynamics and Biocommunications Division, AL/CFB of the Armstrong Laboratory, AL/CFBE at Wright-Patterson Air Force Base, Ohio. The tests were conducted at the request of the Vulnerability Branch, AL/CFBV, and were sponsored by the JPATS Program Office, ASC/YT. The test program was funded under Workunit 71843101. Test facility and engineering support were provided by DynCorp Inc. under contract F33601-96-DJ001. Manikin technical support was provided by Systems Research Laboratories under the AL/CFB Engineering Services Contract.

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## INTRODUCTION

### Background

The Joint Primary Aircraft Training System (JPATS) manikins were designed in order to provide the Defense Department with a standardized manikin which would accommodate the expanded pilot population, and which could be used to evaluate cockpit ejection biodynamic stresses at levels unsafe for human subject volunteers. An initial series of impact tests was conducted in 1995 with the Small and Large JPATS manikins in the +z, -x, and +y axes at Armstrong Laboratory and the results documented (2,3). However, during catapult and upward ejection tests in a Martin-Baker MKUS16LA seat, the lower torso of the Large JPATS was observed rotating forward under the lap belt and partially out of the seat. This response was not observed in the GARD CG-98 (CG-95 ballasted to 245 lbs) manikin during similar catapult tests. It was therefore decided to simulate these conditions with a series of impact tests at Armstrong Laboratory with a Large JPATS manikin and a ballasted GARD CG manikin.

### Test Objectives

1. To measure the acceleration, loading, and displacement time histories of the Large JPATS and GARD CG manikins in a simulated MKUS16LA ejection seat when exposed to 10 G impacts in the +z axis.
2. To analyze these data in order to compare the biodynamic responses of the Large JPATS manikin to the GARD CG manikin, and to determine whether there are unique inertial properties inherent in the Large JPATS manikin which could be considered as causative factors in the apparent excessive lower torso motion observed during testing in the MKUS16LA seat.
3. To implement, test, and evaluate the modifications necessary to reduce the lower torso motion of the Large JPATS manikin.

## METHODS

### Test Facility

All tests were conducted on the Armstrong Laboratory Vertical Deceleration Tower (VDT) using plunger 102 (4). The VDT consists of a carriage which is hoisted on guide rails to a predetermined height and accelerated by gravity into a cylinder filled with water. The magnitude of the deceleration pulse is determined by the drop height of the carriage, and the deceleration profile by the shape of a meter plunger mounted on the bottom of the carriage.

### Test Fixture

All tests were conducted using the VIP seat fixture, which consists of a wooden seat pan and seat back bolted to a metal frame which is rigidly mounted to the carriage. A headrest was mounted in-line with the seat back. The manikins were tested in the seated, upright posture. The plane of

the seat pan was inclined 15° from the horizontal plane and the seat back was inclined 14° with respect to the vertical plane. The distance from the front edge of the seat pan to the intersection of the seat pan and seat back (seat reference point (SRP)) was 16". A five inch long wooden wedge with 6° inclination was mounted on top of the seat pan and flush with the seat pan's back edge. In some cells, a two inch wooden extension piece was bolted to the front of the seat pan, effectively extending its length to 18".

A hinged plate was mounted to the bottom of the seat fixture and was employed as a footrest for the manikins. The legs were hoisted up by raising the front of the plate 20-24° until the manikins' heels were just below the horizontal plane of the seat pan. The legs were bent slightly and the thighs were suspended several inches above the seat pan surface. The plate was then tied to the sides of the seat pan with breakaway cord which was capable of supporting the legs during rest and freefall, but not during impact.

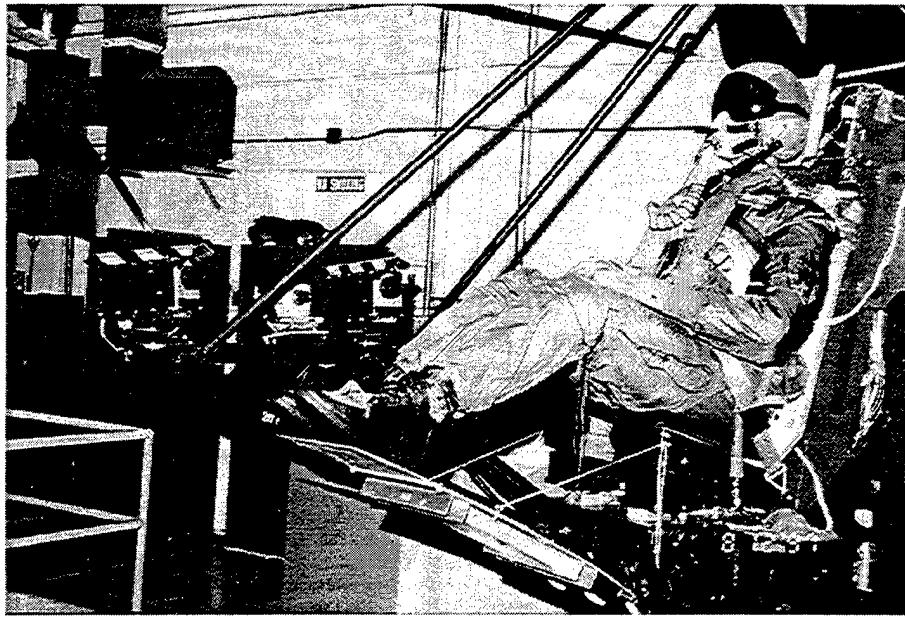
#### Restraint

The manikins were restrained with a standard PCU-15/P harness and lap belt combination. The harness shoulder straps were attached through interface straps to a single bracket affixed to a tri-axial load cell. The load cell was positioned approximately 1" forward of the seat back and 27" up from the SRP, and bolted securely to the frame. The anchor points for the lap belt were positioned alongside the seat pan, approximately 0.5" forward and 0.75" down from the SRP and attached to load cells which were bolted to the frame.

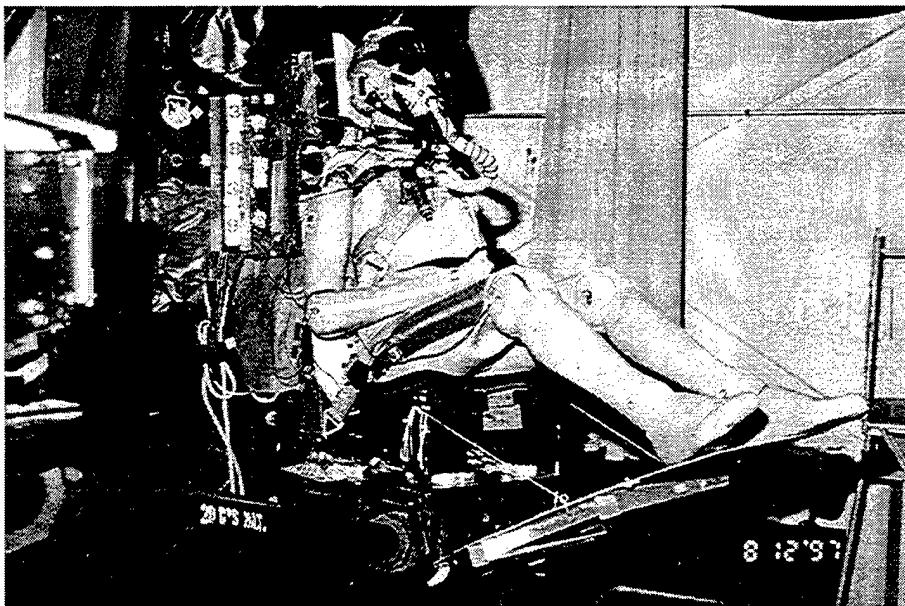
Just prior to testing, the restraint straps were pre-loaded to  $20 \pm 5$  lbs at all attachment points. The manikins' hands were folded and positioned so they were resting on the lap, and were loosely tied together with a Velcro strap. The manikin was centered in the seat in the straight-up seated position, with the lower back pressed against the seat back.

#### Subjects and Equipment

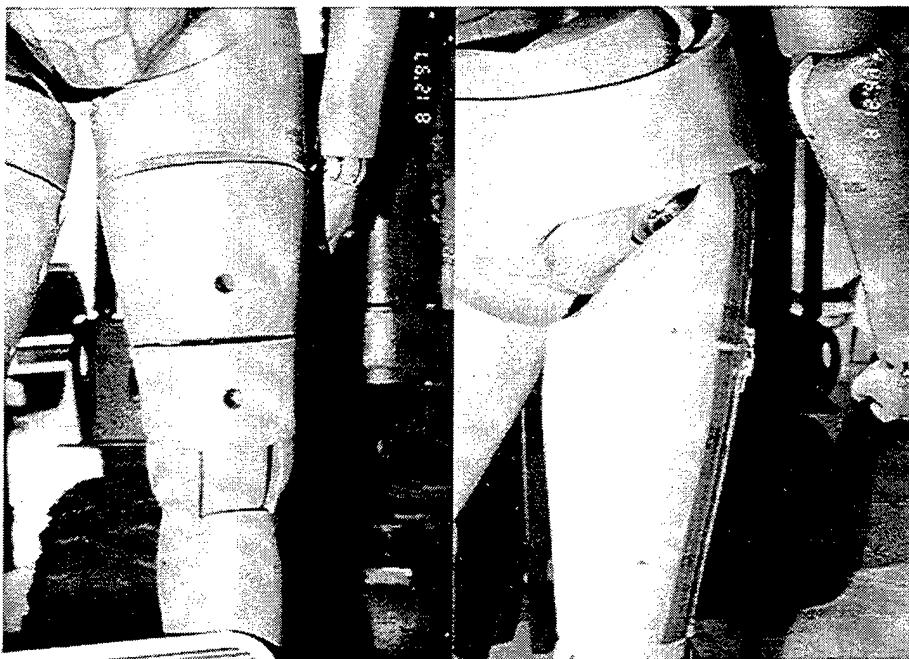
One Large JPATS manikin, weighing 245 lbs, was used in the test program. It was tested with full flight gear which included standard HGU-55/P helmet/visor, MBU-12/P oxygen mask, PCU-15/P harness, flight suit, anti-g suit, life vest, and boots (Figure 1). This increased the manikin's total weight to 270 lbs. A small number of tests were also conducted with the Large JPATS manikin wearing no flight gear except the helmet/visor and mask (Figure 2). Several modifications were made to the Large JPATS manikin during the course of the program in order to improve the inertial response of its lower torso. The segmented upper leg covers were replaced after the first series of tests with one-piece leg covers (Figure 3). The bronze knees were replaced with lighter aluminum knees, and an amount of lead equal to the difference between the weights of the two sets of knees (6.6 lbs) was added to the upper portion of the femur rods (Figure 4). The 95th percentile feet were replaced with 50th percentile feet which had the effect of reducing the weight of the feet by a total of 3 lbs. These modifications had the combined effect of shifting the total manikin center of gravity approximately one centimeter horizontally toward the SRP and one centimeter vertically upwards from the SRP. A full



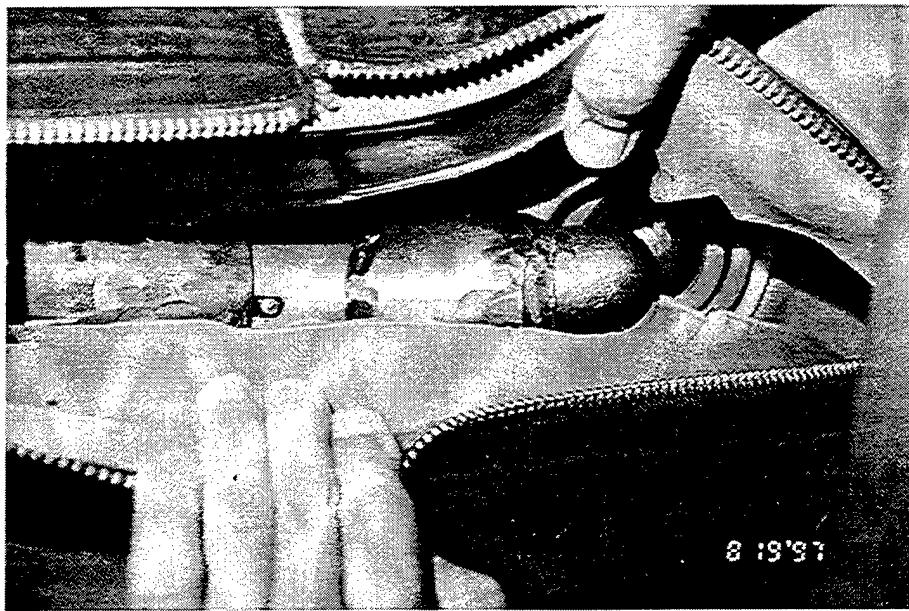
**Figure 1. Large JPATS Manikin in Full Flight Gear**



**Figure 2. Large JPATS Manikin Wearing Only  
Helmet/Visor and Mask**



**Figure 3. Large JPATS Manikin Segmented and One-Piece Leg Covers**



**Figure 4. Large JPATS Manikin Femur Rod with  
Added Lead Weight**

description of the Large JPATS manikin's inertial properties and measurement techniques was presented at the 1997 SAFE Symposium (1). One GARD CG manikin with a base weight of 173 lbs was also tested. It was ballasted internally in the upper chest with 71 lbs of lead shot which increased its total weight to 244 lbs, in order to simulate a GARD CG-98 manikin (Figure 5). The total weight of the GARD CG manikin with full flight gear was 266 lbs (Figure 6). One standard Martin-Baker foam seat cushion was also employed for all manikin tests. The cushion was firmly attached to the seat pan with Velcro tape.

### Instrumentation and Data Processing

Both manikins were fitted with an external tri-axial accelerometer which was mounted on an aluminum block and secured to the chest with a Velcro strip. Single-axis load cells and load links were mounted underneath the seat pan, behind the seat back, and behind the head rest, in order to measure seat and head rest forces. Tri-axial load cells were also placed at the harness attachment points in order to measure shoulder and lap belt forces. All transducers were calibrated before and after the test program. Signal amplification, filtering, and temporary storage of the data were accomplished by an on-board data acquisition system (Pacific Instruments). The data were collected at 1,000 samples per second and downloaded after each test via a whip cable to a PC computer. The data were then transferred to a DEC 3000 computer for processing and copied to optical media for permanent storage. The data were plotted for review after each test using a "quick-look" routine and later re-processed in a more complete format for data analysis. A detailed description of the transducers, instrumentation system, and data processing techniques is given in Appendix A.

### Motion Analysis Data

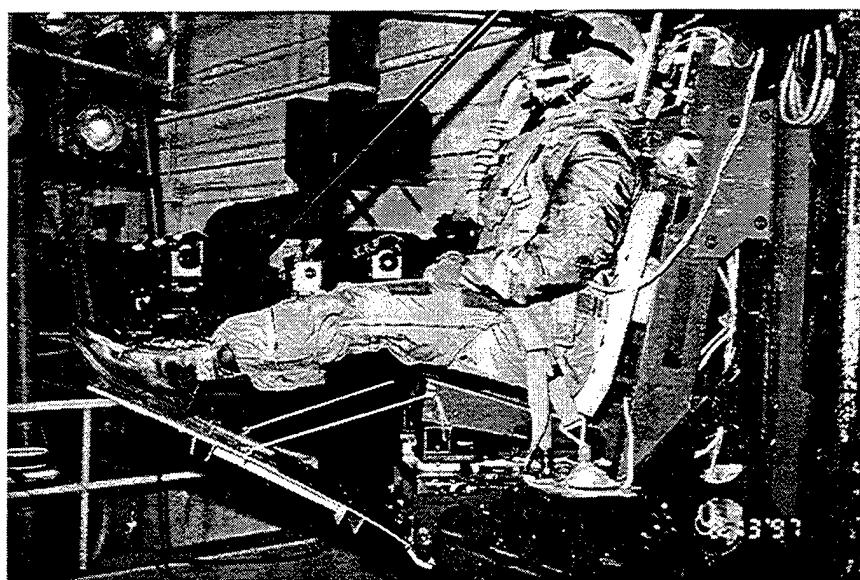
Motion analysis data were collected for all impact tests starting just prior to carriage free-fall. The data were collected with two Selspot infrared cameras that recorded the position of LED markers on the manikin at 500 samples per second (5). The cameras were secured on special mounts attached to the carriage at right and oblique angles to the manikin. Processed Selspot data consisted of displacement time histories, relative displacement curves, and velocity time histories. Positions for the infrared targets are given in Appendix A. In addition to the Selspot cameras, a single Kodak high-speed video camera was secured to a carriage camera mount and used for visual documentation of the impact event. Still documentation photographs were taken before and after each test.

### Experimental Design

A total of 20 tests were performed on the VDT in the +z axis. All tests were conducted at peak acceleration levels of approximately 10 G. The acceleration profile approximated a half-sine with pulse duration of 130-150 ms. The tests were conducted according to the specifications in the Test Matrix shown in Table 1.



**Figure 5. GARD CG Manikin with Ballast**



**Figure 6. GARD CG Manikin in Full Flight Gear**

**Figure 6. GARD CG Manikin in Full Flight Gear**

**Table 1. Test Matrix**

Test Cell	Upper Leg Cover	Knees	Flight Suit	Flight Boots	Seat pan Length	Foot Plate Extension
A	Segmented	Bronze	Yes	Yes	16"	Yes
B	One-piece	Bronze	Yes	Yes	16"	Yes
C	One-piece	Alum*	Yes	Yes	16"	Yes
D	One-piece	Alum*	Yes	Yes	18"	Yes
E	One-piece	Bronze	No	No	16"	Yes
F	One-piece	Bronze	No	Yes	16"	Yes
G	One-piece	Alum*	Yes	Yes	18"	No

\*Modified Large JPATS included aluminum knees, smaller feet, and lead weight added to upper legs

## RESULTS

### Test-by-Test Narrative

**TEST 3830:** JPATS-L CELL PT

Profile test - limited data collected. Wrists unsecured for first four tests.

**TEST 3831:** JPATS-L CELL PT

Profile test - limited data collected

**TEST 3832:** JPATS-L CELL A

Foot plate angle 14° from horizontal plane, heel 9" below seat pan bottom. Prior to test - seat cushion was secured to seat pan with Velcro.

**TEST 3833:** JPATS-L CELL A

Foot plate angle 31°, heel level with seat pan bottom. Prior to test - right knee loosened, wrists tied together, seat wedge secured with screws.

**TEST 3834:** JPATS-L CELL A

Prior to test - 8" extension bolted to footplate, angle of footplate 20-24°, and heel approximately level with bottom of seat pan for all remaining tests.

**TEST 3835:** JPATS-L CELL A

**TEST 3836:** JPATS-L CELL B

**TEST 3837:** JPATS-L CELL B

**TEST 3838:** JPATS-L CELL B

Heel to SRP measured at approximately 40".

**TEST 3839:** JPATS-L CELL E

Less lower torso motion observed in video than in previous tests.

**TEST 3840:** JPATS-L CELL F

Prior to test - knee loosened. Less lower torso motion observed - similar to 3839.

TEST 3841: GARD CELL B

Placard incorrectly reads JPATS-L. Legs almost straight out on foot plate, could not be bent as much as JPATS-L. Very limited lower torso motion in all three GARD manikin tests.

TEST 3842: GARD CELL B

Placard incorrectly reads JPATS-L. Heel to SRP distance approximately 36.5".

TEST 3843: GARD CELL B

Heel to SRP distance approximately 35.5".

TEST 3844: JPATS-L CELL C

Prior to test - Manikin weight 241 lbs, with full flight gear and helmet 269 lbs. Manikin lower torso motion was reduced during all tests in this cell.

TEST 3845: JPATS-L CELL C

TEST 3846: JPATS-L CELL C

Prior to test, Hip LED was taped more securely in place.

TEST 3847: JPATS-L CELL D

Manikin lower torso motion was reduced during all tests in this cell - similar to tests in Cell C.

TEST 3848: JPATS-L CELL D

TEST 3849: JPATS-L CELL D

TEST 3850: JPATS-L CELL G

Almost no manikin forward hip motion was observed during both tests in this cell.

TEST 3851: JPATS-L CELL G

### Biodynamic Test Data

**Table 2. Mean Peak Acceleration/Force Data**

	JPAT	JPAT	GARD	JPAT	JPAT	JPAT	JPAT	JPAT
DATA CHANNEL	A	B	B	C	D	E	F	G
Carriage Z Accel (G)	9.90	9.94	9.92	9.80	9.86	9.89	9.91	9.67
Chest X Accel (G)	13.1	15.4	3.82	13.7	13.9	20.9	26.5	10.6
Chest Z Accel (G)	16.6	15.7	19.9	15.1	16.5	20.0	23.2	18.6
Shoulder Force X (LBS)	142	172	20.0	156	148	169	174	190
Shoulder Force Z (LBS)	111	128	38.2	117	114	123	112	113
Lap Force X (LB)	256	257	0.36	123	68.8	73.7	53.8	0.72
Lap Force Z (LB)	316	372	-1.8	173	105	96.0	63.6	-1.5
Seat Force Res (LB)	3857	3747	4364	3878	3927	4172	4356	3810

**Table 3. Mean Peak Displacement Data**

	JPAT	JPAT	GARD	JPAT	JPAT	JPAT	JPAT	JPAT
SELSPOT CHANNEL	A	B	B	C	D	E	F	G
Chest Z Disp (IN)	3.62	3.26	3.27	3.61	3.77	4.46	4.30	5.34
Knee X Disp (IN)	1.58	1.08	0.36	0.55	0.33	0.09	0.0	0.25
Knee Z Disp (IN)	8.85	8.46	2.63	6.31	5.73	8.05	9.11	1.63
Hip X Disp (IN)	1.91	0.98	0.34	0.79	0.38	0.09	0.60	0.26
Hip Z Disp (IN)	1.72	2.19	1.59	2.22	1.92	2.02	2.02	1.53

## DISCUSSION

### Martin-Baker Ejection Tower Simulation

The conditions for the tests in Cell A were designed to duplicate the conditions of tests conducted at Martin-Baker's ejection tower in England. Using the test parameters described in the Test Matrix section, the tests in Cell A demonstrated the same excessive motion and pitch in the lower torso of the Large JPATS manikin that were observed in the Martin-Baker tests. This duplication of test results was necessary in order to determine which conditions were causing or contributing to the excessive motion, and to evaluate the effectiveness of modifications intended to reduce the associated loads and displacements.

### Seat Modifications

Seat Pan and Seat Back Angles: The seat pan and seat back angles did not appear to contribute to the excessive lower torso motion under the conditions tested. In Cell G with seat pan and seat back angles of 15° and 14° respectively, and without the foot extension plate, only very minimal hip motion, knee motion, and lap belt forces were observed in the Large JPATS manikin during impact.

Foot Extension Plate: The foot extension plate was employed to position the feet and legs in approximately the same pre-ejection position as in the Martin-Baker MKUS16LA seat with rudder pedals. It was designed to drop out at impact much like a hinged trap door. When the plate was employed in tests with the modified Large JPATS manikin in the extended seat (Cell D), the peak lap belt forces were measured at 70 lbs and 105 lbs in the x and z axes respectively. When the plate was eliminated under otherwise identical conditions (Cell G), the lap belt forces became negligible, and the hip and knee displacements decreased, particularly the downward knee displacement. Analysis of the slow-motion video showed that in cells using the foot plate, the thighs were allowed to drop several inches before contacting the surface of the seat pan. Since about one-third of the thigh was initially extended out in front of the seat pan, this "thigh-slap" created a rotational force on the hips which pulled them downward and forward, thus placing an outward tension on the lap belt. The increased hip motion also contributed to a 30% increase in x-axis chest acceleration, although z-axis chest acceleration and displacement decreased only slightly.

Seat Pan Extension: Extending the length of the seat pan from 16" (Cell C) to 18" (Cell D) had the effect of decreasing both the lap belt forces and the forward hip and knee displacements by about half. Slight decreases were also observed in the downward hip and knee displacements.

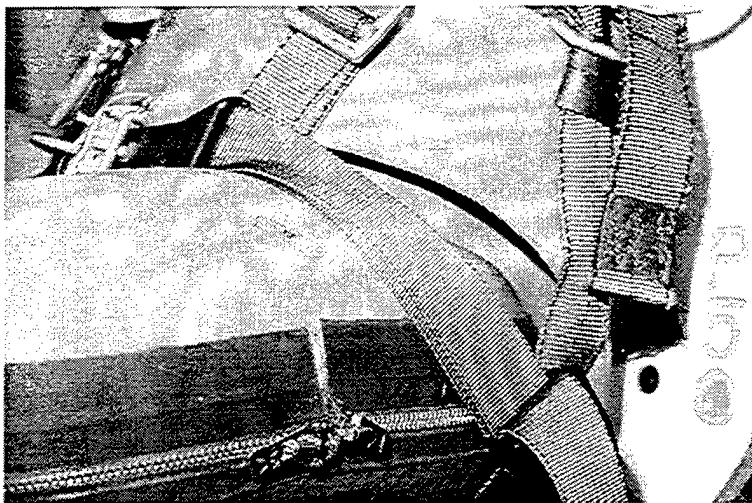
### Flight Gear

(Cell E). In addition, forward knee and hip displacements increased to 1" compared to negligible displacements in tests with no flight gear. The increase in forward hip motion also resulted in 10% lower seat pan forces. Apparently the fabric of the flight suit has a much smoother texture than the rubber skin of the manikin when in contact with the seat cushion, and therefore allows the manikin's hips to more readily slide forward during impact. However, the flight gear apparently has a restrictive effect on upper torso motion since decreases of approximately 25% were observed in downward chest displacement and in both z-axis and x-axis chest accelerations.

Flight Boots: When flight boots were added to the Large JPATS manikin (Cell F), lap belt forces decreased slightly and forward hip motion increased slightly as compared to the no flight gear condition (Cell E). Chest accelerations also increased when wearing flight boots.

#### Large JPATS Modifications

Abdominal Insert: The Large JPATS manikin has a gap between the abdominal insert and the pelvis as shown in Figure 7. During some tests without the flight suit (Cells E and F) the lap belt slid slightly into the gap, somewhat toward the manikin's sides. The amount of belt slippage was less than one inch and was further minimized by wearing the flight suit in the remainder of the cells. No corrective action was taken during the test program.



**Figure 7. Large JPATS Manikin Showing Gap Between Abdominal Insert and Pelvis**

Upper Leg Segment Modification: Switching the Large JPATS manikin's upper leg cover from a multi-segment (Cell A) to a single-segment upper leg cover (Cell B) appeared to somewhat reduce forward hip and knee displacements, although downward hip and knee displacements as well as lap belt forces were not appreciably different with either leg cover.

Leg Weight/Center of Mass Modification: In addition to replacing the leg covers, the Large JPATS manikin was modified by decreasing the weight of the kneecaps, adding an equivalent

Leg Weight/Center of Mass Modification: In addition to replacing the leg covers, the Large JPATS manikin was modified by decreasing the weight of the kneecaps, adding an equivalent amount of weight back to the upper thighs, and decreasing weight of the feet (see Methods section). These modifications resulted in a decrease of the impact forces on the lap belt by about half, as seen in a comparison of responses of the unmodified (Cell B) and modified (Cell C) Large JPATS manikin. Smaller decreases were observed in the forward and downward knee displacements and in the forward hip displacement. These modifications had the effect of shifting the manikin's center of mass slightly inward and upward so that the downward motion of the legs did not exert as much pulling force on the hips, resulting in less hip and knee motion and lower lap belt forces.

Combined Modifications: Tests employing the Large JPATS single segment leg cover, the leg weight/center of mass shift, and the seat pan extension modifications (Cell D) were compared to tests with none of these modifications (Cell A). In Large JPATS tests with the modifications, lap belt forces were reduced by two-thirds, and significant decreases were observed in the forward and downward knee displacements and in the forward hip displacement. It is apparent that employing all these modifications provides greater reductions in lap belt loading and hip/knee displacements than can be obtained with any of the individual modifications.

#### GARD CG Manikin

Impact tests were conducted with the ballasted GARD CG manikin and the Large JPATS manikin under identical conditions (Cell B). The results indicated that chest acceleration in the GARD CG was relatively high in the z-axis but low in the x-axis, which resulted in very low shoulder harness forces. Results also indicated that the lap belt forces were almost negligible compared to several hundred pounds on the Large JPATS manikin. Also, the hip and knee displacements were significantly lower in the GARD CG than in the Large JPATS manikin. Since most of the weight in the GARD CG manikin is in the upper chest cavity and not in the legs, the rotational effect of the thighs pulling on the hips and the resulting x-axis chest acceleration at impact are greatly reduced. The effect of this response is that the GARD CG manikin essentially stays put in the seat, much the same as the Large JPATS does when tested without the foot extension plate. Since essentially all the weight of the GARD CG stays in the seat pan, the seat pan resultant force is several hundred pounds larger than in equivalent Large JPATS tests.

#### CONCLUSIONS

1. The biodynamic response of the Large JPATS manikin during catapult tests in a Martin-Baker MKUS16LA ejection seat could be accurately demonstrated with impact tests using a modified test seat and foot extension plate on the Vertical Deceleration Tower at Armstrong Laboratory.

2. The excessive lower torso motion of the Large JPATS manikin was due primarily to four factors: the pre-impact positioning of the manikin's thighs above the seat pan, the fabric of the flight suit, the length of the seat pan, and the center of mass of the manikin's lower torso.
3. The lower torso motion and associated lap belt loading of the Large JPATS manikin were significantly reduced, although not eliminated, by performing the following modifications: adjusting the manikin's center of mass through weight reduction/relocation in the legs, switching from multi-segment to single segment upper leg covers, and extending the length of the seat pan.
4. The large "thigh gap" which was present between the manikin and the seat pan during tests conducted with the foot extension plate could have serious implications for human occupants due to the potential for spinal misalignment during ejections. This phenomenon would be more pronounced with large occupants, and with ejection seats having rudder pedals at a height close to the horizontal plane of the seat pan.

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## **APPENDIX A**

### **TEST CONFIGURATION AND DATA ACQUISITION SYSTEM**

TEST CONFIGURATION AND  
DATA ACQUISITION SYSTEM FOR THE  
+GZ IMPACT TESTS OF THE LARGE JPATS MANIKIN  
IN A SIMULATED MARTIN-BAKER  
EJECTION SEAT  
(JMB Study)  
TEST PROGRAM

Prepared under  
Contract F3301-96-DJ001

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## **INTRODUCTION**

The DynCorp Armstrong Laboratory Division prepared this report for the Armstrong Laboratory Escape and Impact Branch (AL/CFBE) under Air Force Contract F3301-96-DJ001. It describes the test facility, seat fixture, restraint configuration, test subjects, test configurations, data acquisition, and the instrumentation procedures that were used in The  $+G_z$  Impact Tests of the Large JPATS Manikin in a Simulated Martin-Baker Ejection Seat (JMB Study) Test Program. Twenty tests were conducted between 5 Aug and 26 Aug 1997 on the Vertical Deceleration Tower Test facility.

### **1. TEST FACILITY**

The AL/CFBE Vertical Deceleration Tower (Figure A-1) was used for all of the tests. The facility consists of a 60-foot vertical steel tower, which supports a guide rail system, an impact carriage supporting a plunger, a hydraulic deceleration device and a test control and safety system. The impact carriage can be raised to a maximum height of 39 feet prior to release. After release, the carriage free falls until the plunger, attached to the undercarriage, enters a water filled cylinder mounted at the base of the tower. The subject experiences a deceleration impulse as the plunger displaces water in the cylinder. The deceleration profile is determined by the free fall distance, the carriage and test specimen mass, the shape of the plunger and the size of the cylinder orifice. A rubber bumper is used to absorb the final impact as the carriage stops.

For these tests, plunger Number 102 was mounted under the carriage. Drop height varied depending on the test cell requirements, which ranged from 11'4" to 12'2".

### **2. SEAT FIXTURE**

The VIP seat fixture (Figure A-2) was used for all of the tests. The seat was designed to withstand vertical impact accelerations up to 50 G. The adjustable seat back was reclined 14° from vertical and the seat pan was tilted up 15° from horizontal. One of the test variables was seat pan length. The requirement was a 2-inch extension and a block of wood was bolted to the front of the seat to accomplish those test cells. Figure A-3 shows the seat pan positioning with the 2-inch extension attached. The headrest was in line with the seat back. A hinged plate was mounted to the bottom of the seat fixture and was employed as a footrest for the manikins. The plate was raised up 20° to 24°, which suspended the manikins' heels several inches above the seat pan surface. The plate was then tied to the sides of the seat pan with a breakaway cord, which was capable of supporting the legs during rest and freefall but not during impact. Figure A-4 depicts the seat test configuration. The subject was secured in the seat with a standard USAF double shoulder strap restraint harness and lap belt configuration. The lap belt and shoulder strap were preloaded to  $20 \pm 5$  pounds, as required in the test plan.

The manikins' hands were folded and positioned so they were resting on the lap and were loosely tied together with a Velcro strap. The manikin was centered in the seat sitting straight up with the lower back pressed against the seat back.

### **3. TEST SUBJECT**

Two manikins were used for this test program: a large JPATS (JPATS-L) manikin weighing 245 lbs. and a GARD CG manikin weighing 244 lbs. The GARD CG-98 manikin was simulated by adding lead ballast in the upper chest of a CG-95 manikin to achieve the desired test weight. The GARD manikin was tested in full flight gear.

The large JPATS-L manikin was tested in three configurations, and with and without full flight gear. The three configurations were:

- (1) Segmented upper leg cover and bronze knee
- (2) Single piece upper leg cover and bronze knee
- (3) Single piece upper leg cover and aluminum knee

## 4. TEST CONFIGURATIONS

The detailed manikin test configurations are outlined below:

Test Cell	Upper Leg Cover	Knees	Flight Suit	Flight Boots	Seat Pan Length	Foot Plate Extension
A	Segmented JPATS-L	Bronze	Yes	Yes	16"	Yes
B	One-Piece JPATS-L	Bronze	Yes	Yes	16"	Yes
B	GARD CG-98	Standard	Yes	Yes	16"	Yes
C	One-Piece JPATS-L	Aluminum	Yes	Yes	16"	Yes
D	One-Piece JPATS-L	Aluminum	Yes	Yes	18"	Yes
E	One-Piece JPATS-L	Bronze	No	No	16"	Yes
F	One-Piece JPATS-L	Bronze	No	Yes	16"	Yes
G	One-Piece JPATS-L	Aluminum	Yes	Yes	18"	Yes

Table A- 1: Test Matrix

## 5. INSTRUMENTATION

Accelerometers and load transducers were chosen to provide the optimum resolution over the expected test load range. Full scale data ranges were chosen to provide the expected full scale range plus 50% to assure the capture of peak signals. All transducer bridges were balanced for optimum output prior to the start of the program. The accelerometers were adjusted for the effect of gravity in software by adding the component of a 1 G vector in line with the force of gravity that lies along the accelerometer axis

The accelerometer and load transducer coordinate systems are shown in Figure A-5. The seat coordinate system is right-handed with the z-axis parallel to the seat back and positive upward. The x-axis is perpendicular to the z-axis and positive eyes forward from the subject. The y-axis is perpendicular to the x and z-axes according to the right-hand rule. The origin of the seat coordinate system is designated as the seat reference point (SRP). The SRP is at the midpoint of the line segment formed by the intersection of the seat pan and seat back. All vector components (for accelerations, angular accelerations, forces, moments, etc.) were positive when the vector component (x, y and z) was in the direction of the positive axis.

The linear accelerometers were wired to provide a positive output voltage when the acceleration experienced by the accelerometer was applied in the +x, +y and +z directions. The load cells and load links were wired to provide a positive output voltage when the force exerted by the load cell on the subject was applied in the +x, +y or +z direction. All transducers, except the carriage accelerometers and the carriage velocity tachometer, were referenced to the seat coordinate system. The carriage tachometer was wired to provide a positive output voltage during freefall. The carriage accelerometers were referenced to the carriage coordinate system. The measurement instrumentation used in this test program is listed in Table A-2.

Carriage velocity was measured using a Globe Industries tachometer Model 22A672-2. The rotor of the tachometer was attached to an aluminum wheel with a rubber "O" ring around its circumference to assure good rail contact. The wheel contacted the track rail and rotated as the carriage moved, producing an output voltage proportional to the velocity.

## 5.1 Accelerometers

The external chest accelerometer package consisted of three Endevco Model 7264-200 linear accelerometers mounted to a 1/2 x 1/2 x 1/2-inch aluminum block. The accelerometer packages were inserted into a steel protection shield to which a length of Velcro fastener strap was attached. The package was placed over the subject's sternum at the level of the xiphoid and was held there by fastening the Velcro strap around the subject's chest. An infrared LED chest target was attached directly on top of the chest accelerometer package.

Carriage z acceleration was measured using one Endevco Model 2262A-200 linear accelerometers. The accelerometer was mounted on a small acrylic block and located behind the seat on the VIP seat structure.

Seat accelerations were measured using three Endevco linear accelerometers: two Models 7264-200 for accelerations in the y and z directions and one model 2264-200 for acceleration in the x direction. The three linear accelerometers were attached to a 1 x 1 x 3/4-inch acrylic block and were mounted near the center of the load cell mounting plate.

## **5.2 Load Transducers**

Shoulder/anchor forces were measured using three AAMRL/DYN 3D-SW triaxial load cells, each capable of measuring forces in the x, y and z directions. The parameters measured are indicated below:

- Shoulder x, y and z force
- Left lap belt x, y and z force
- Right lap belt x, y and z force.

The lap/vertical anchor force triaxial load cells were located on separate brackets mounted on the side of the seat frame parallel to the seat pan. The shoulder strap force triaxial load cell was mounted on the seat frame between the seat back support plate and the headrest. The load transducer locations are shown in Figure A-5.

Left, right and center seat forces were measured using three load cells and three load links. The three load cells included three Strainsert Model FL2.5U-2SPKT load cells. DynCorp fabricated the three load links (Figure A-6) using Micro Measurement Model EA-06-062TJ-350 strain gages. All measurement devices were located under the seat pan support plate. The load links were used for measuring loads in the x and y directions, two in the x direction and one in the y direction. Each load link housed a swivel ball, which acted as a coupler between the seat pan and load cell mounting plate. The Strainsert load cells were used for measuring loads in the z direction.

## **5.3 Calibration**

Calibrations were performed before and after testing to confirm the accuracy and functional characteristics of the transducers. Pre-program and post-program calibrations are given in Table A-3. The Precision Measurement Equipment Laboratories (PMEL) at Wright-Patterson Air Force Base calibrated all Strainsert load cells. PMEL calibrated these devices on a periodic basis and provided current sensitivity and linearity data.

The calibration of the accelerometers was performed by DynCorp using the comparison method (Ensor, 1970). A laboratory standard accelerometer, calibrated on a yearly basis by Endevco with standards traceable to the National Bureau of Standards, and a test accelerometer were mounted on a shaker table. The frequency response and phase shift of the test accelerometer were determined by driving the shaker table with a random noise generator and analyzing the outputs of the accelerometers with an MS-DOS PC computer using Fourier analysis. The natural frequency and the damping factor of the test accelerometer were determined, recorded and compared to previous calibration data for that test accelerometer. Sensitivities were calculated at 40 G and 100 Hertz. The sensitivity of the test accelerometer was determined by comparing its output to the output of the standard accelerometer.

DynCorp calibrated the shoulder/lap triaxial load cells and load links. These transducers were calibrated to a laboratory standard load cell in a special test fixture. The sensitivity and linearity of each test load cell were obtained by comparing the output of the test load cell to the output of the laboratory standard under identical loading conditions. The laboratory standard load cell, in turn, is calibrated by PMEL on a periodic basis.

The velocity wheel is calibrated periodically by DynCorp by rotating the wheel at approximately 2000, 4000 and 6000 revolutions per minute (RPM) and recording both the output voltage and the RPM.

## **6. DATA ACQUISITION**

The Master Instrumentation Control Unit in the Instrumentation Station controls data acquisition. Using a comparator, a test was initiated when the countdown clock reaches zero. The comparator is set to start data collection at a preselected time.

A reference mark pulse was generated to mark the Model 5600A electronic data and Selspot optical motion data at a preselected time after test initiation to place the reference mark close to the impact point. The reference mark time was used as the start time for data processing of the electronic and Selspot optical motion data.

Prior to placing a subject in the seat, data was recorded to establish a zero reference for all transducers. The reference data was stored separately from the test data and was used in the processing of the test data.

### **6.1 Model 5600 Portable Data Acquisition System**

The Model 5600A Portable Data Acquisition System (DAS), manufactured by Pacific Instruments, was used for this test program. The Model 5600A DAS is a ruggedized, DC powered, fully programmable signal conditioning and recording system for transducers and events. The Model 5600A DAS is designed to withstand a 50G shock in any direction. The Model 5600A DAS is housed in two units and its installation on top of the seat carriage is shown in Figure A-7.

Each of the two units can accommodate up to 28 transducer channels and 32 events. The signal conditioning accepts a variety of transducers including full and partial bridges, voltage, and piezoresistive. Transducer signals are amplified, filtered, digitized and recorded in onboard solid state memory. The data acquisition system is controlled through an IEEE-488.1 interface using the GPIB instruction language.

An MS-DOS pentium PC with an AT-GPIB board configures the 5600A before testing and retrieves the data after each test. The PC stores the raw data and then passes it on to a DEC 3000-500 Alpha computer for processing and output to permanent storage and printouts. Figure A-8 shows the relationships between the data acquisition, data analysis and data storage equipment.

The DynCorp program 'TDR5600' on the PC handles the interface with the Model 5600A DAS. It includes options to compute and store zero reference voltage values; collect and store a binary zero reference data file; compute and display preload values; and collect and store binary test data. The program communicates over the GPIB interface.

Test data could be reviewed after it was converted to digital format using the "quick look" SCAN\_EME routine on the DEC Alpha computer. SCAN\_EME produced a plot of the data stored for each channel as a function of time. The routine determined the minimum and maximum values of each data plot. It also calculated the rise time, pulse duration, and carriage acceleration, and created a disk file containing significant test parameters.

## 6.2 Selspot Motion Analysis System

The Selspot Motion Analysis System utilizes photosensitive cameras to track the motion of infrared LED targets attached to different points on the test fixture. The three-dimensional motion of the LEDs was determined by combining the images from two different Selspot cameras. The two Selspot cameras were mounted onboard the carriage. The side camera was a Selspot Model 412 (S/N 457) and the oblique camera was a Selspot Model 412 (S/N 458). Both cameras had 24mm lenses. A Motorola 68030 VME based microcomputer in the camera interface unit handles camera control and photogrammetric data collection. An MS DOS PC, running Selspot MULTILAB System software, is used to trigger the Selspot system, process the data, generate printouts, and temporarily store the data. Periodically, the data files are passed to the DEC 3000-500 Alpha for permanent archive. Figure A-9 is a block diagram of the Selspot data collection system.

The Selspot System was calibrated by determining the camera locations and orientations prior to the start of the test program. The camera locations and orientations were referenced to the coordinate system of the Position Reference Structure (PRS). The PRS is shaped as a tetrahedron with reference LEDs 1, 2, 3 and 4 located at the vertices. The PRS is shown in Figure A-10.

Motion of the subjects' knee, hip, elbow, shoulder, and chest were quantified by tracking the motion of subject-mounted LEDs. Four reference LEDs were placed on the test fixture. The locations of the LEDs generally followed the guidelines provided in "Film Analysis Guides for Dynamic Studies of Test Subjects, Recommended Practice (SAE J138, March 1980)." Figure A-11 identifies the LED target locations.

Photogrammetric data was collected from the six moving and four reference LEDs at a 500 Hz sample rate during the impact. Data collection started at  $T = -3$  seconds for 5 seconds. The data

was processed starting at the reference mark time for 600 milliseconds on the Selspot Motion Analysis System. The camera image coordinates were corrected for camera vibration, converted into three-dimensional coordinates, and transformed into the seat coordinate seat.

A Kodak Ektapro 1000 video system was also used to provide onboard coverage of each test. This video recorder and display unit is capable of recording high-speed motion up to a rate of 1000 frames per second. Immediate replay of the impact is possible in real time or in slow motion.

## 7. PROCESSING PROGRAMS

The executable image for the TDR5600 processing program is located in directory PROCESS of the DEC 3000-500 AXP Alpha computer and the test data is assumed to be stored in logical directory DATADIR. All plots and the test summary sheet are output to the LN03 laser printer. The test summary file is stored in directory PROCESS.

The Fortran program that processes the test data for the JMB Study (Vertical Deceleration Tower System) is named JMBVDT. The character string 'JMB' identifies the study and 'VDT' identifies the system (Vertical Deceleration Tower). Logical directory DATADIR is assumed to contain a zero reference file named '<test no>Z.VDT', a test data file named '<test no>D.VDT' and a sensitivity file named '<test no>S.VDT'. JMBVDT assumes that the test data was collected using the 5600A data acquisition system.

JMBVDT requests the user to enter the total number of tests to be processed and the test number for each test. The default test parameters are retrieved from the header block of the test data file and displayed as a menu on the screen. The user may specify new values for any of the displayed test parameters. The test parameters include the subject id, weight, age, height and sitting height. Additional parameters include the cell type, nominal G level, subject type (manikin or human) and belt preload status (computed or not computed). If the belt preloads were computed, then the shoulder and lap preloads are also displayed.

JMBVDT generates time histories for the carriage x, y and z axis accelerations; the carriage velocity; the seat x, y and z axis accelerations; and the external chest x, y, z and resultant accelerations. Time histories are generated for the upper and lower headrest x forces and their sum; the shoulder x, y, z and resultant forces; the left lap x, y, z and resultant forces; and the right lap x, y, z and resultant forces.

Time histories are generated for the forces on the seat pan load cells. These forces include the left and right seat x axis forces and their sum; the seat y axis force; the left, right and center seat z axis forces and their sum; the seat resultant force; and the tare corrected seat z and resultant forces. Values for the preimpact level and the extrema for each time history are stored in the test base file and printed out as a summary sheet for each test. The time histories are also plotted.

The parameter file 'JMBVDT.SET' controls the output from JMBVDT. The parameter file can be used to enable or disable the generation of the data base summary file, the LN03 printer summary sheets, the LN03 plots, and text files containing channel time histories. The parameter file also allows the user to specify the analysis window time and the plot time increment. This allows the user to rerun the analysis without regenerating unnecessary printer output and text files.

The parameter file 'JMBVDT.LST' controls the creation of the text files containing channel time histories. The time history files are created with the filename '<Test Number>VDT.L<File Number>'. The file number starts at one and is incremented for each additional time history file that is created.

**DYNCORP DIGITAL INSTRUMENTATION REQUIREMENTS**

**+Gz IMPACT TESTS OF THE LARGE JPATS  
MANIKIN IN A SIMULATED MARTIN-BAKER SEAT  
(JMB STUDY)**

**PROGRAM**

**FACILITY VERTICAL DECELERATION TOWER**

**DATES: 05-AUG-97 THRU 26-AUG-97**

**RUN NUMBERS: 3830 - 3851**

DATA CHAN	DATA POINT	XDUCER MFG & TYPE	SERIAL NUMBER	XDUCER SENS	ENCIRLE VOLTS/CHAN	FILTER SERIES S/N	RAMP GAIN S/N	SAMPLE RATE	FULL SCALE SENS	FILTER HZ	XDUCER ZERO RANGE	BRIDGE BALANCE RES	BRIDGE CORP RES	SPECIAL NOTATIONS
0	VELOCITY	GLOBE 22A672-2	4	0.1580 v/ft/sec	-0	-	1	1K	63.3 ft/sec	120	0 ±10V	-	-	RAG SENSITIVITY = 0.1857 V/REV SEC (1.2 IN/FT/4.56 IN/REV) X 0.1857 V/F SEC = 0.4887 V/FT ATEN (3.094) = 0.1580 V/FT SEC.
1	CARRIAGE Z ACCEL.	ENDEVCO 2264A-200	MH82	2.067 mv/g	10.00 1	-	100	1K	48.4 g	120	0 ±10V	-	-	
2	CARRIAGE X ACCEL.	ENDEVCO 2264-200	CB09	2.945 mv/g	10.00 2	-	200	1K	17.0 g	120	0 ±10V	-	-	
3	CARRIAGE Y ACCEL.	ENDEVCO 2264-200	BN36	3.287 mv/g	10.00 3	-	100	1K	30.4 g	120	0 ±10V	-	-	1.5K
4	SEAT X ACCEL.	ENTRAN EGB-73B-200DF	95H14-A05	2.801 mv/g	10.00 4	-	100	1K	35.7 g	120	0 ±10V	-	-	1.5K
5	SEAT Y ACCEL.	ENTRAN EGB-73B-200DF	95H14-A07	2.566 mv/g	10.00 5	-	200	1K	19.5 g	120	0 ±10V	+3IN TO GND	-	
6	SEAT Z ACCEL.	ENTRAN EGB-73B-200DF	95D95C10-G03	2.479 mv/g	10.00 6	-	100	1K	40.3 g	120	0 ±10V	+1IN TO GND	-	
7	EXT CHEST X ACCEL.	ENTRAN EGB-73B-200DF	95D95C10-G01	2.722 mv/g	10.00 7	-	100	1K	36.7 g	120	0 ±10V	-35K -IN TO GND	-	

PACIFIC INSTRUMENTS MODEL 5600A ACQUISITION SYSTEM USED.

Table A- 2: DIGITAL INSTRUMENTATION REQUIREMENTS  
(PAGE 1 OF 4)

**DYNCORP DIGITAL INSTRUMENTATION REQUIREMENTS**

**+GZ IMPACT TESTS OF THE LARGE JPATS  
MANIKIN IN A SIMULATED MARTIN-BAKER SEAT  
(JMB STUDY)**

**PROGRAM**

**FACILITY**      **VERTICAL DECELERATION TOWER**

**DATES: 05-AUG-97 THRU 26-AUG-97**

**RUN NUMBERS: 3830 - 3851**

DATA CHAN	DATA POINT	XDUCER MFG & TYPE	SERIAL NUMBER	XDUCER SENS	EXCITE VOLT CHAN	FILTER SERIES S/N	AMP GAIN S/N	SAMPLE RATE FORMAT	FULL SCALE SENS	FILTER HZ	XDUCER ZERO RANGE	BRIDGE BALANCE RES	BRIDGE COMP RES	SPECIAL NOTATIONS
8	EXT. CHEST Y ACCEL.	ENTRAN EGE-73B-200DF	9509510-G02	2.729 mv/G	10.00 8	-	200	1K	16.3 G	120	0 ±10V	-IN TO GND	-	
9	EXT. CHEST Z ACCEL.	ENTRAN EGE-73B-200DF	95195106-D02	2.665 mv/G	10.00 9	-	50	1K	75.0 G	120	0 ±10V	-	-	
10	LEFT SEAT PAN Z LOAD	STRAININSERT FL2.5U	7135-1	8.03 µv/lb	10.00 10	-	500	1K	2491 LB	120	0 ±10V	-	-	
11	RIGHT SEAT PAN Z LOAD	STRAININSERT FL2.5U	7135-2	8.00 µv/lb	10.00 11	-	500	1K	2500 LB	120	0 ±10V	-	-	
12	CEN. SEAT PAN Z LOAD	STRAININSERT FL2.5U	7135-4	7.96 µv/lb	10.00 12	-	200	1K	6281 LB	120	0 ±10V	-	-	
13	LEFT LAP X LOAD	MICH-SCIEN. 4000	2X	13.78 µv/lb	10.00 13	-	500	1K	725.7 LB	120	0 ±10V	-	-	
14	LEFT LAP Y LOAD	MICH-SCIEN. 4000	2Y	13.21 µv/lb	10.00 14	-	500	1K	1514 LB	120	0 ±10V	-	-	
15	LEFT LAP Z LOAD	MICH-SCIEN. 4000	2Z	13.33 µv/lb	10.00 15	-	500	1K	1500 LB	120	0 ±10V	-	-	
16	RIGHT LAP X LOAD	MICH-SCIEN. 4000	3X	13.93 µv/lb	10.00 16	-	500	1K	1436 LB	120	0 ±10V	-	-	
17	RIGHT LAP Y LOAD	MICH-SCIEN. 4000	3Y	13.32 µv/lb	10.00 17	-	500	1K	1502 LB	120	0 ±10V	-	-	

**TABLE A-2: DIGITAL INSTRUMENTATION REQUIREMENTS  
(PAGE 2 OF 4)**

**DYNCORP DIGITAL INSTRUMENTATION REQUIREMENTS**

+Gz IMPACT TESTS OF THE LARGE JPATS  
MANIKIN IN A SIMULATED MARTIN-BAKER SEAT  
(IMB STUDY)

**PROGRAM**

**FACILITY** VERTICAL DECELERATION TOWER

DATES: 05-AUG-97 THRU 26-AUG-97

RUN NUMBERS: 3830 - 3851

DATA CHAN	DATA POINT	XDUCER MFG & TYPE	SERIAL NUMBER	XDUCER SENS	EXCITE VOLT CHAN	FILTER SERIES S/N	AMP GAIN S/N	SAMPLE RATE FORMAT	FULL SCALE SENS	FILTER HZ	XDUCER ZERO RANGE	BRIDGE BALANCE RES	BRIDGE COMP RES	SPECIAL NOTATIONS
18	RIGHT LAP Z LOAD	MICH-SCIENCE 4000	32	13.43 μV/LB	10.00 /18	-	500 /-	1K /-	1490 LB	120	0 ±1.0V	-	-	
19	SHOULDER X LOAD	AMRL/DYN 3D-SR	202	6.21 μV/LB	10.00 /19	-	500 /-	1K /-	3220 LB	120	0 ±1.0V	+23K IN TO GND	-	
20	SHOULDER Y LOAD	AMRL/DYN 3D-SR	20Y	5.25 μV/LB	10.00 /20	-	500 /-	1K /-	3810 LB	120	0 ±1.0V	+21K IN TO GND	-	
21	SHOULDER Z LOAD	AMRL/DYN 3D-SR	20X	4.82 μV/LB	10.00 /21	-	500 /-	1K /-	4150 LB	120	0 ±1.0V	-	-	
EVENT CHAN, 0/28	EVENT	-	-	1.0 VOLT	-	-	-	1K /-	-	WB	-	-	-	
EVENT CHAN, 1/28	T=0	-	-	1.0 VOLT	-	-	-	1K /-	-	WB	-	-	-	
22	LEFT SEAT X LOAD	AMRL/DYN EA-06-062TJ-350	1	10.41 μV/LB	10.00 /22	-	500 /-	1K /-	1922 LB	120	0 ±1.0V	+15.6K IN TO GND	-	
23	RIGHT SEAT X LOAD	AMRL/DYN EA-06-062TJ-350	2	10.21 μV/LB	10.00 /23	-	500 /-	1K /-	1958 LB	120	0 ±1.0V	+4.3K IN TO GND	-	
24	SEAT Y LOAD	AMRL/DYN EA-06-062TJ-350	3A	10.66 μV/LB	10.00 /24	-	500 /-	1K /-	1876 LB	120	0 ±1.0V	+50K IN TO GND	-	

TABLE A- 2: DIGITAL INSTRUMENTATION REQUIREMENTS  
(PAGE 3 OF 4)

## DYNCORP DIGITAL INSTRUMENTATION REQUIREMENTS

## +Gz IMPACT TESTS OF THE LARGE JPATS MANIKIN IN A SIMULATED MARTIN-BAKER SEAT (JMB STUDY)

PROGRAM

## VERTICAL DECELERATION TOWER FACILITY

RUN NUMBERS: 3830 - 3851

TABLE A- 2: DIGITAL INSTRUMENTATION REQUIREMENTS  
(PAGE 4 OF 4)

+Gz IMPACT TESTS OF THE LARGE JPATS  
MANIKIN IN A SIMULATED MARTIN-BAKER SEAT  
(JMB STUDY)

PROGRAM

FACILITY

VERTICAL DECELERATION TOWER

DATES: 05-AUG-97 THRU 26-AUG-97

RUN NUMBERS: 3830 - 3851

**DYNCORP PROGRAM CALIBRATION LOG**

DATA POINT	TRANSDUCER	SERIAL NUMBER	PRE DATE	- CAL	POST DATE	- CAL	% CHANGE	NOTES
VELOCITY	MFG. & MODEL GLOBE 22A672-2	4	13-NOV-96	0.1580 V/FT/SEC	-	-	-	Raw Sensitivity = 0.1857 V/REV/SEC (12 IN FT/.56 IN/REV) X 0.1857 V/REV/ SEC = 0.4887 V/FT ATTEN. @ 3.094; 0.4887 V/FT/3.094 = 0.1580 V/FT/SEC.
CARRIAGE Z ACCEL.	ENDEVCO 2262A-200	MH82	08-APR-97	2.067 mV/G	09-SEP-97	2.067 mV/G	0	
CARRIAGE X ACCEL.	ENDEVCO 2264-200	CB09	25-JUL-97	2.915 mV/G	09-SEP-97	2.969 mV/G	+0.8	
CARRIAGE Y ACCEL.	ENDEVCO 2264-200	BNS6	25-JUL-97	3.287 mV/G	09-SEP-97	3.279 mV/G	-0.2	
SEAT X ACCEL.	ENTRAN EGE-73B-200DF	95H14-A05	08-APR-97	2.801 mV/G	09-SEP-97	2.817 mV/G	+0.6	
SEAT Y ACCEL.	ENTRAN EGE-73B-200DF	95H14-A07	08-APR-97	2.536 mV/G	09-SEP-97	2.578 mV/G	+0.5	
SEAT Z ACCEL.	ENTRAN EGE-73B-200DF	95C10-G03	03-APR-97	2.419 mV/G	09-SEP-97	2.487 mV/G	+0.3	
CHEST X ACCEL.	ENTRAN EGE-73B-200DF	95D95C10- G01	21-MAY-97	2.722 mV/G	09-SEP-97	2.707 mV/G	-0.5	
CHEST Y ACCEL.	ENTRAN EGE-73B-200DF	95D95C10- G02	25-JUL-97	2.729 mV/G	09-SEP-97	2.721 mV/G	-0.3	
CHEST Z ACCEL.	ENTRAN EGE-73B-200DF	95I95I06- D02	05-MAY-97	2.655 mV/G	09-SEP-97	2.671 mV/G	+0.2	
LEFT SEAT PAN Z LOAD	STRA.INSERT FL2 .5U2SPKT	7135-1	15-JUL-97	8.03 mV/LB	-	-	-	Calibrated periodically by PMEL personnel.
RIGHT SEAT PAN Z LOAD	STRA.INSERT FL2 .5U2SPKT	7135-2	15-JUL-97	8.00 mV/LB	-	-	-	Calibrated periodically by PMEL personnel.

Table A- 3: TRANSDUCER PRE- AND POST-CALIBRATION  
(PAGE 1 OF 3)

## DYNCORP PROGRAM CALIBRATION LOG

+GZ IMPACT TESTS OF THE LARGE JPATS  
MANIKIN IN A SIMULATED MARTIN-BAKER SEAT  
(JMB STUDY)

PROGRAM

FACILITY      VERTICAL DECELERATION TOWER

DATES: 05-AUG-97 THRU 26-AUG-97

RUN NUMBERS: 3830 - 3851

DATA POINT	TRANSDUCER	SERIAL NUMBER	PRE DATE	- CAL		POST DATE	SENS	- CAL	%CHANGE	NOTES
				SENS	DATE					
CENTER SEAT PAN Z LOAD	STRAININSERT FL2. SU2SPKT	7135-4	15-JUL-97	7.96	μv/LB	-	-	-	-	CALIBRATED PERIODICALLY BY PMEL PERSONNEL.
LEFT LAP X LOAD	MICHIGAN-SCIENTIFIC 4000	2X	12-NOV-96	13.78	μv/LB	10-SEP-97	13.81	μv/LB	+0.2	
LEFT LAP Y LOAD	MICHIGAN-SCIENTIFIC 4000	2Y	12-NOV-96	13.21	μv/LB	10-SEP-97	13.25	μv/LB	+0.3	
LEFT LAP Z LOAD	MICHIGAN-SCIENTIFIC 4000	2Z	12-NOV-96	13.33	μv/LB	10-SEP-97	13.44	μv/LB	+0.8	
RIGHT LAP X LOAD	MICHIGAN-SCIENTIFIC 4000	3X	12-NOV-96	13.93	μv/LB	10-SEP-97	13.90	μv/LB	-0.2	
RIGHT LAP Y LOAD	MICHIGAN-SCIENTIFIC 4000	3Y	12-NOV-96	13.22	μv/LB	10-SEP-97	13.32	μv/LB	+0.2	
RIGHT LAP Z LOAD	MICHIGAN-SCIENTIFIC 4000	3Z	12-NOV-96	13.43	μv/LB	10-SEP-97	13.46	μv/LB	+0.2	
SHOULDER X LOAD	AMRL/DYN 3D-SW	20Z	25-JUL-97	6.21	μv/LB	10-SEP-97	6.16	μv/LB	-0.8	
SHOULDER Y LOAD	AMRL/DYN 3D-SW	20Y	25-JUL-97	5.25	μv/LB	10-SEP-97	5.24	μv/LB	-0.2	
SHOULDER Z LOAD	AMRL/DYN 3D-SW	20X	25-JUL-97	4.82	μv/LB	10-SEP-97	4.82	μv/LB	-0-	
LEFT SEAT X LOAD	AMRL/DYN EA-06-062TU-350	1	12-NOV-96	10.41	μv/LB	10-SEP-97	10.45	μv/LB	+0.4	
RIGHT SEAT X LOAD	AMRL/DYN EA-06-062TU-350	2	12-NOV-96	10.21	μv/LB	10-SEP-97	10.16	μv/LB	-0.5	
CENTER SEAT Y LOAD	AMRL/DYN EA-06-062TU-350	3A	12-NOV-96	10.66	μv/LB	10-SEP-97	10.85	μv/LB	+1.8	
HEADREST UPPER LOAD	STRAININSERT FL1U-25G	209	15-AUG-96	19.69	μv/LB	-	-	-	-	CALIBRATED PERIODICALLY BY PMEL PERSONNEL.

TABLE A-3: TRANSDUCER PRE- AND POST-CALIBRATION (PAGE 2 OF 3)

## DYNCORP PROGRAM CALIBRATION LOG

+Gz IMPACT TESTS OF THE LARGE JPATS MANIKIN IN A SIMULATED MARTIN-BAKER SEAT (JMB STUDY)

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PROGRAM

## VERTICAL DECELERATION TOWER FACILITY

RUN NUMBERS: 3830 - 3851

DATES: 05-AUG-97 THRU 26-AUG-97

TABLE A-3: TRANSDUCER PRE- AND POST-CALIBRATION (PAGE 3 OF 3)

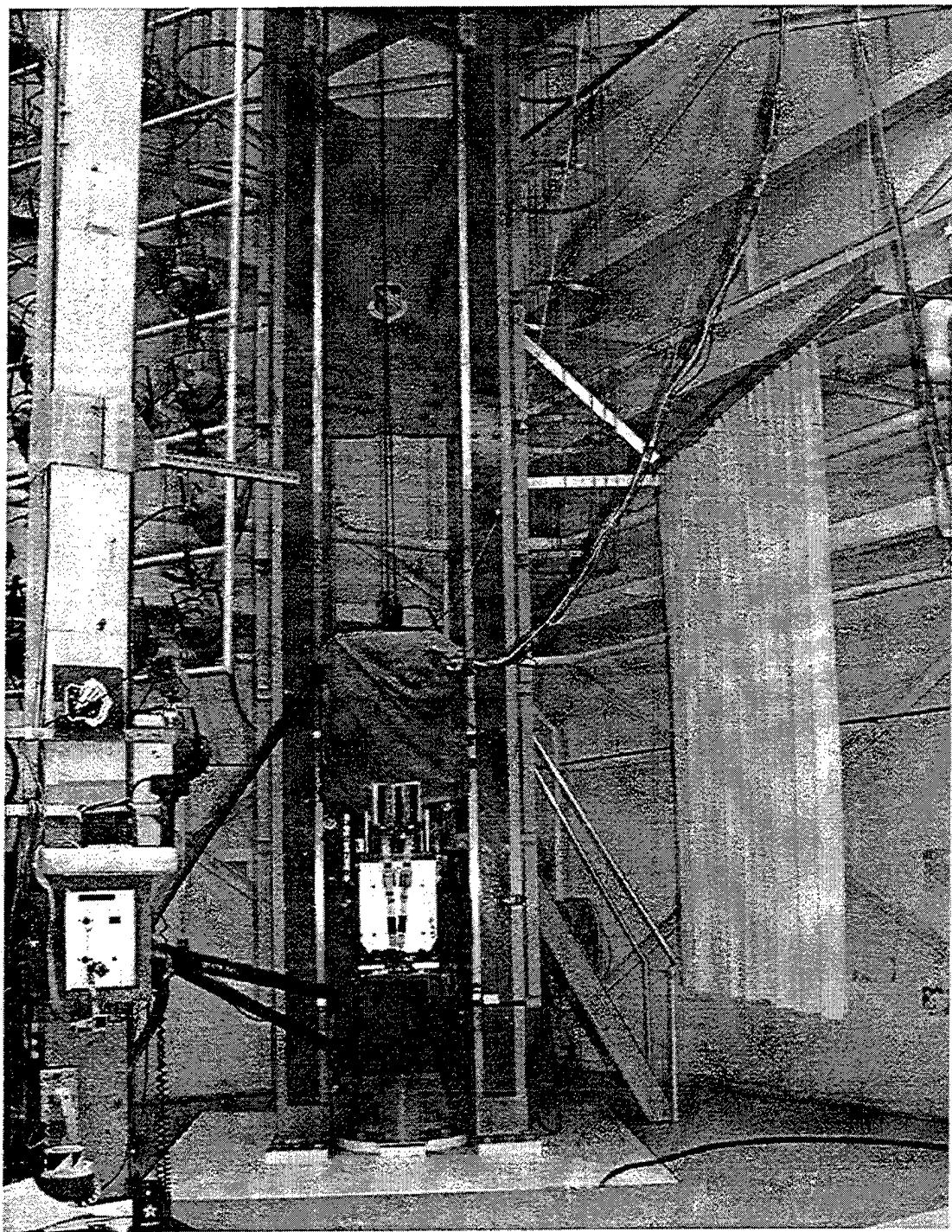


Figure A- 1: AL/CFBE Vertical Deceleration Tower

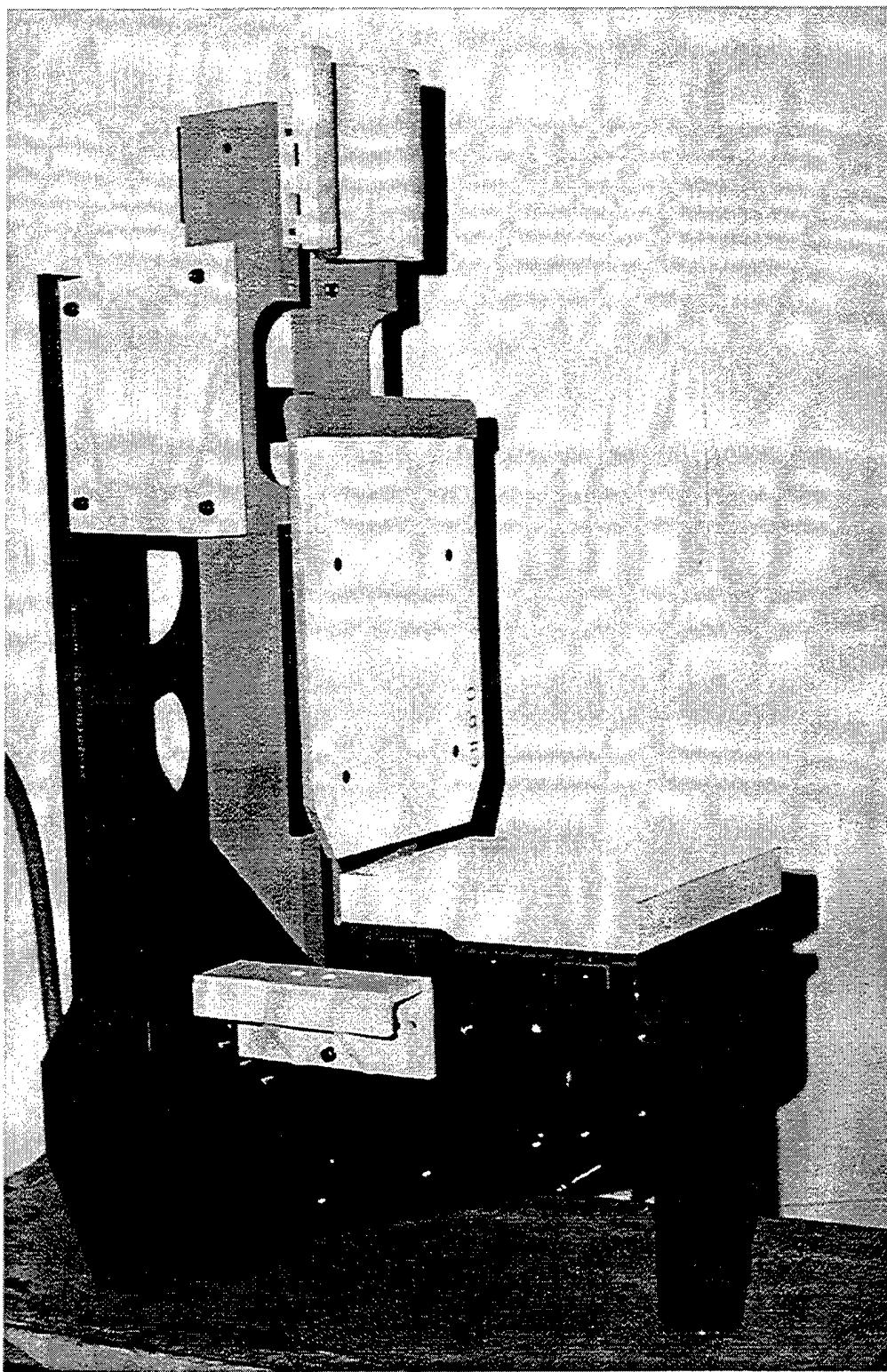


Figure A- 2: Basic VIP Seat

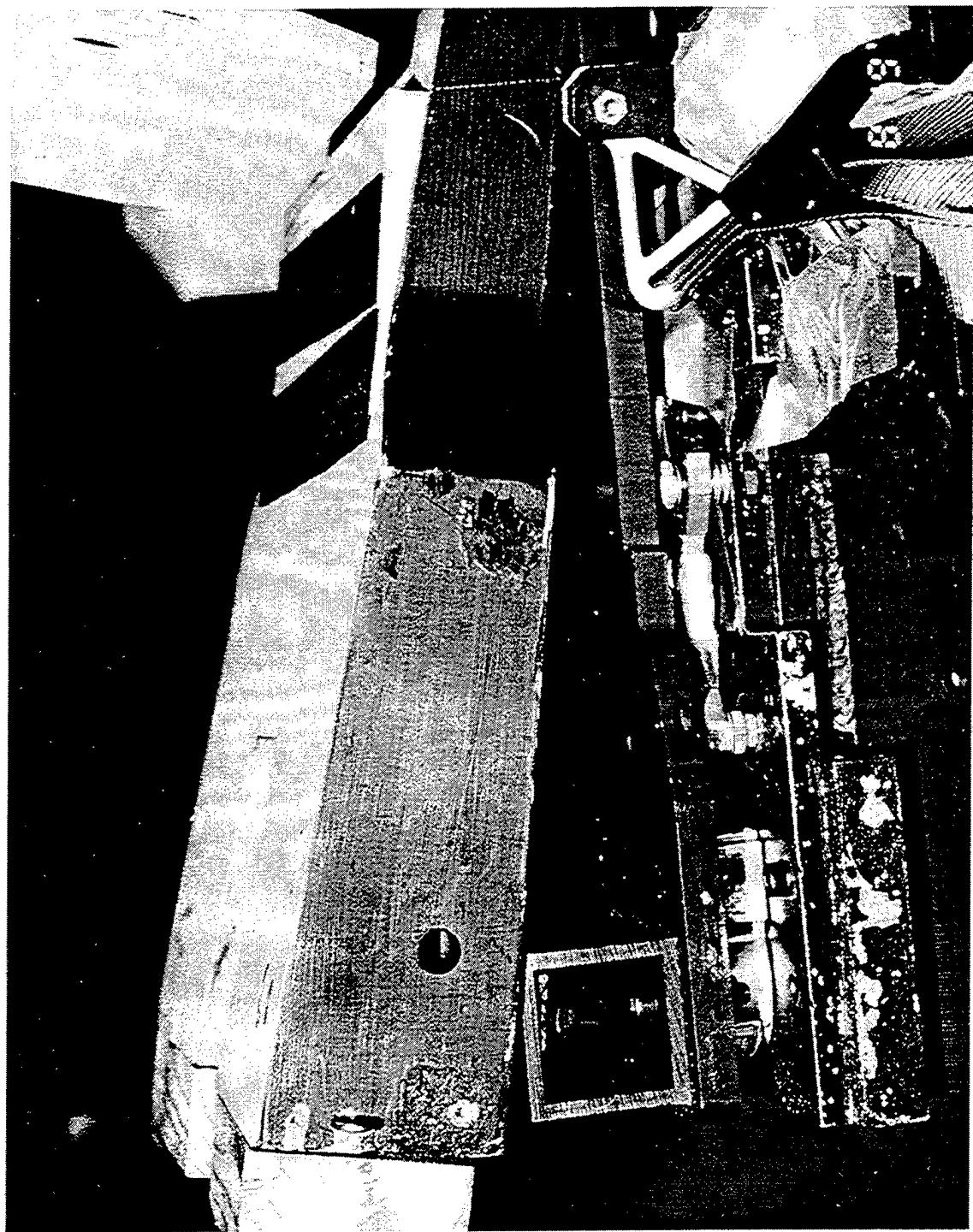


Figure A- 3: Seat Pan Detail showing angle and 2" extension

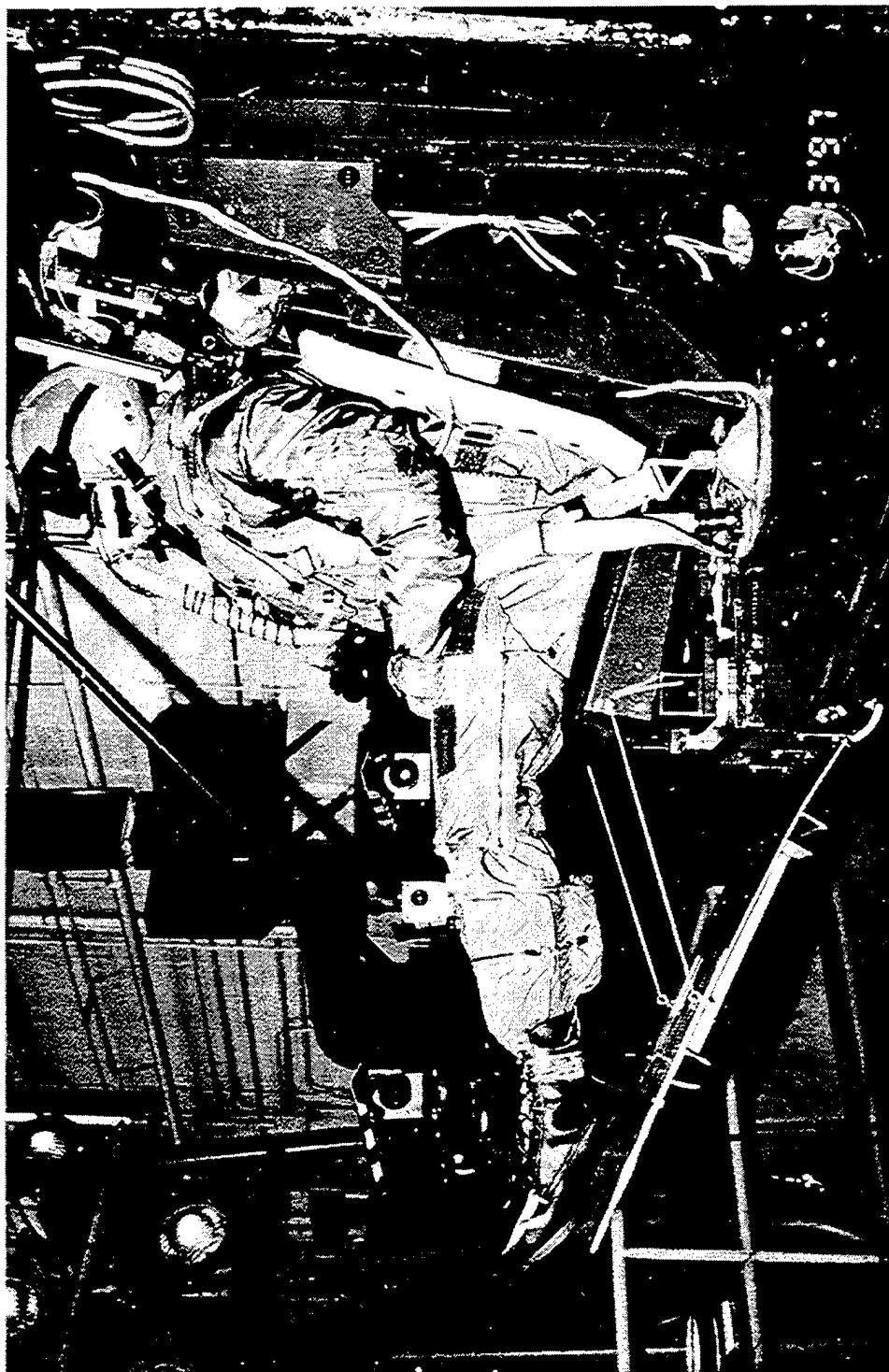
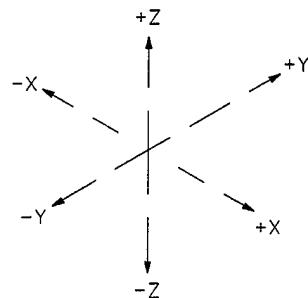
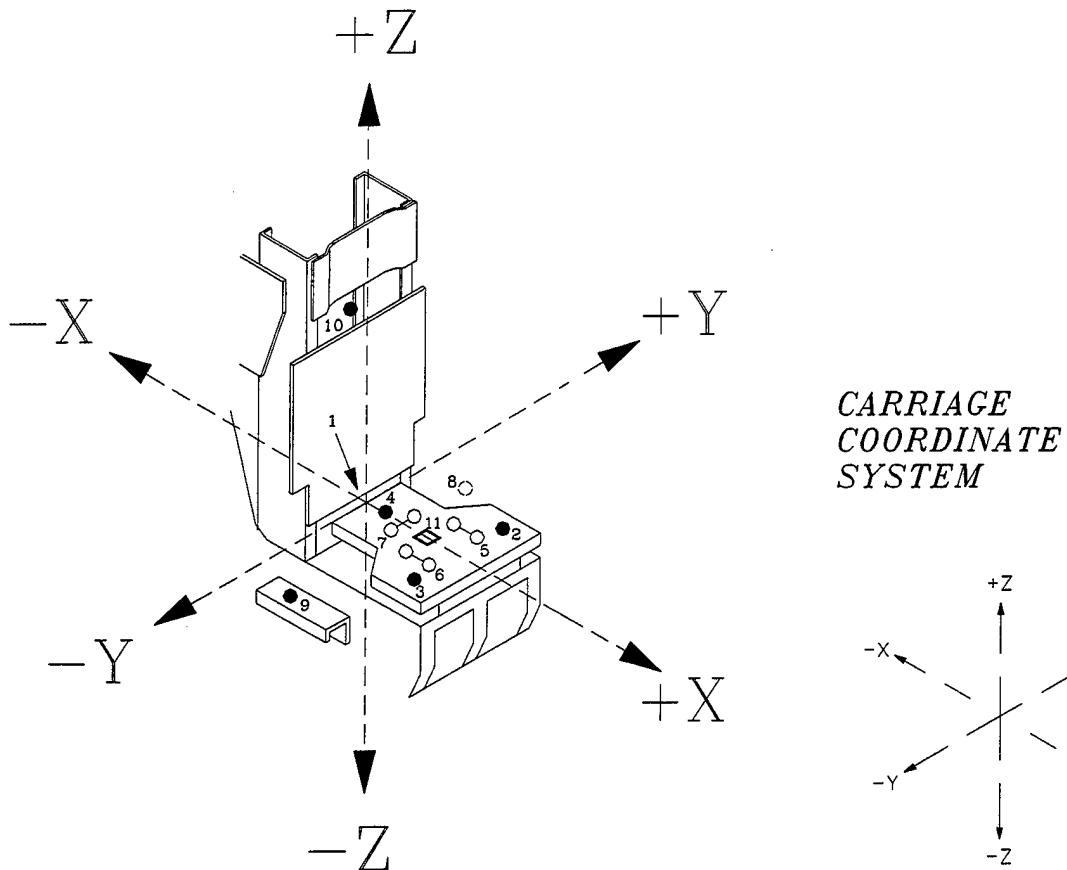


Figure A- 4: JMB Study Seat Configuration



#### TRANSDUCER CONTACT POINT LOCATIONS IN INCHES (CM)

NO.	X	Y	Z	DESCRIPTION
1	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	SEAT REFERENCE POINT
2	17.90 (45.46)	5.00 (12.70)	-1.22 (-3.10)	LEFT SEAT Z FORCE
3	17.90 (45.46)	-5.00 (-12.70)	-1.22 (-3.10)	RIGHT SEAT Z FORCE
4	6.68 (16.96)	0.00 (0.00)	-1.22 (-3.10)	CENTER SEAT Z FORCE
5	10.00 (25.41)	6.00 (15.25)	-1.85 (-4.70)	LEFT SEAT X FORCE
6	10.00 (25.41)	-6.00 (-15.25)	-1.85 (-4.70)	RIGHT SEAT X FORCE
7	9.26 (23.51)	1.99 (5.05)	-1.85 (-4.70)	CENTER SEAT Y FORCE
8	0.81 (2.06)	9.00 (22.86)	-1.61 (-4.10)	LEFT LAP BELT FORCE
9	0.81 (2.06)	-9.00 (-22.86)	-1.61 (-4.10)	RIGHT LAP BELT FORCE
10	-5.47 (-13.90)	0.00 (0.00)	27.39 (69.58)	SHOULDER FORCE
11	12.33 (31.31)	0.00 (0.00)	-1.69 (-4.30)	X, Y, Z ACCELERATION

Figure A- 5: VDT Coordinate System

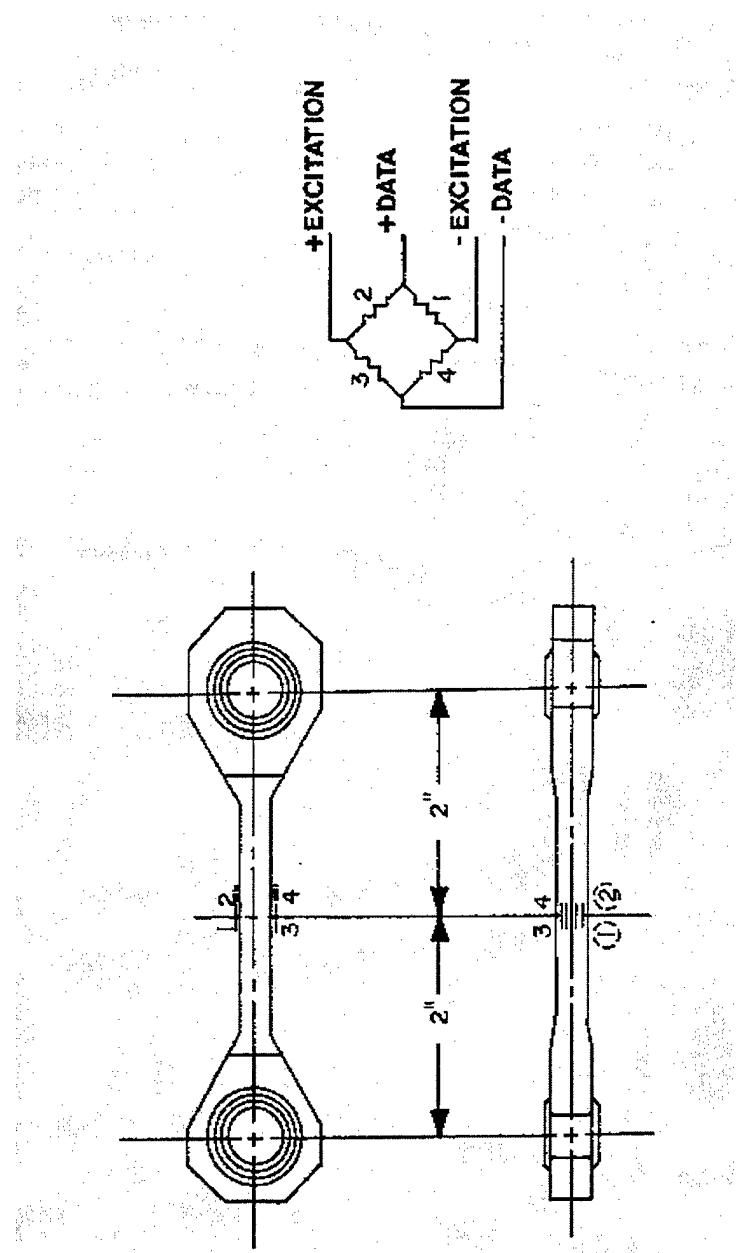


Figure A-6: Load Link Instrumentation

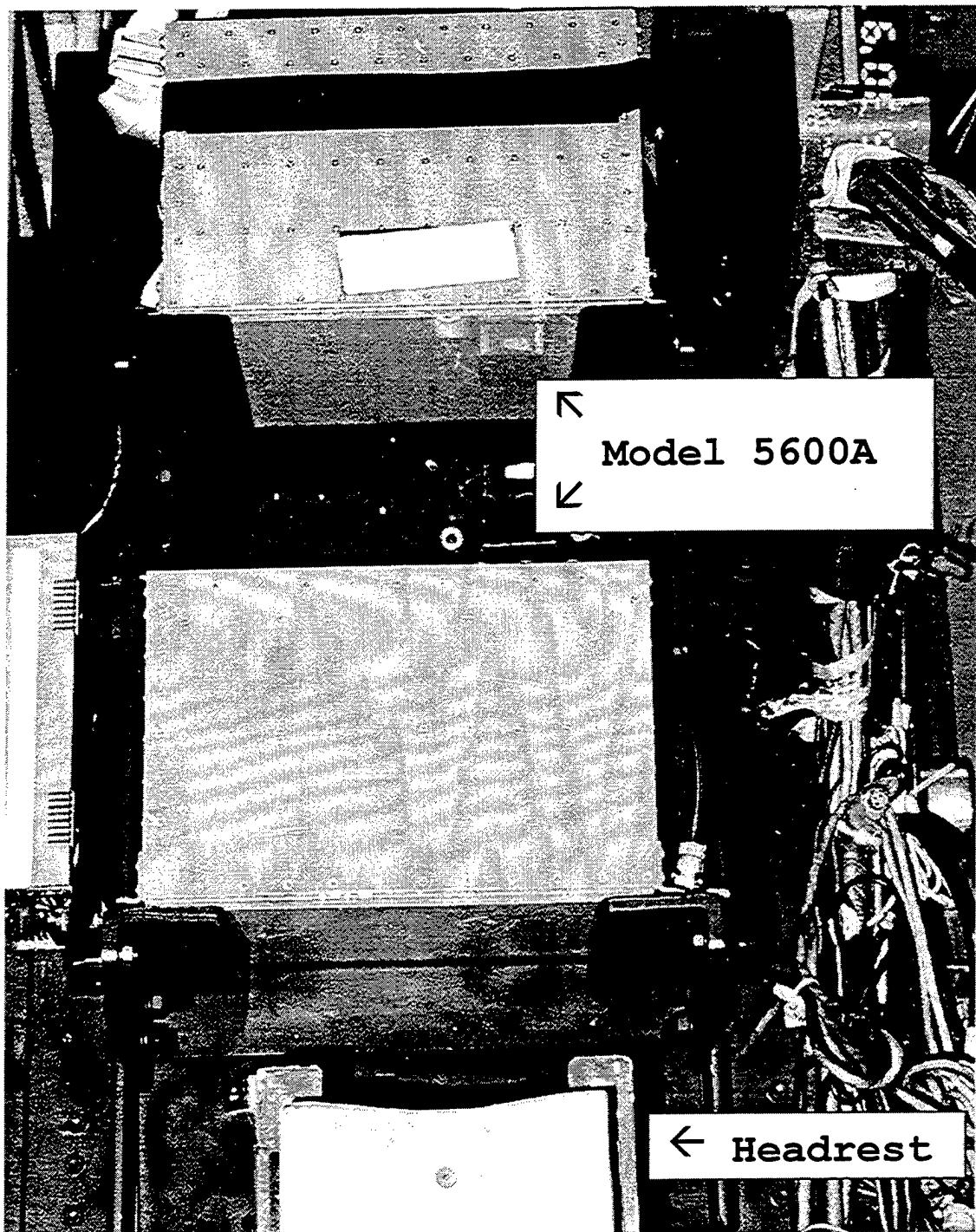


Figure A- 7: Pacific Instruments Model 5600A DAS

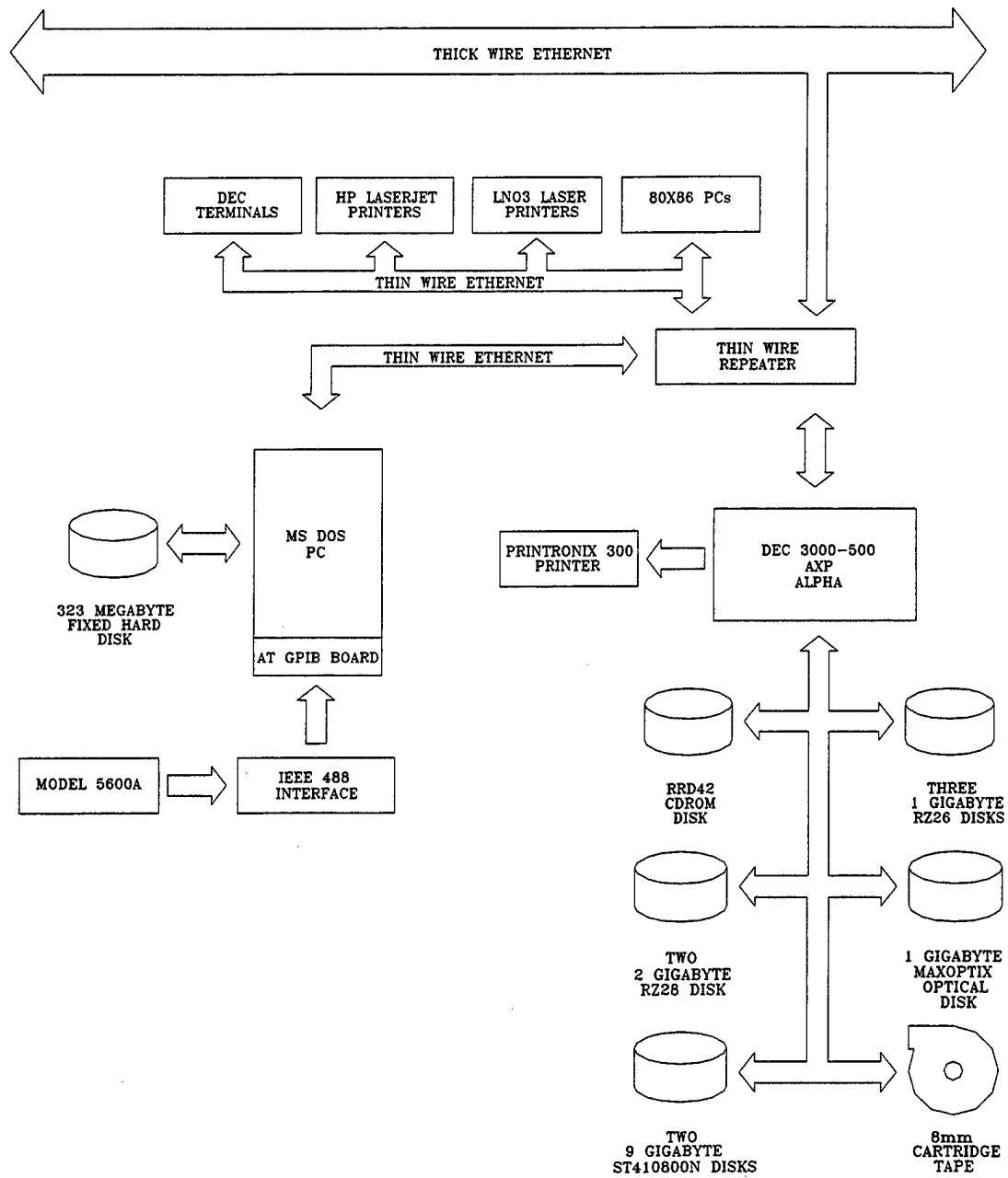


Figure A- 8: Data Acquisition Architecture

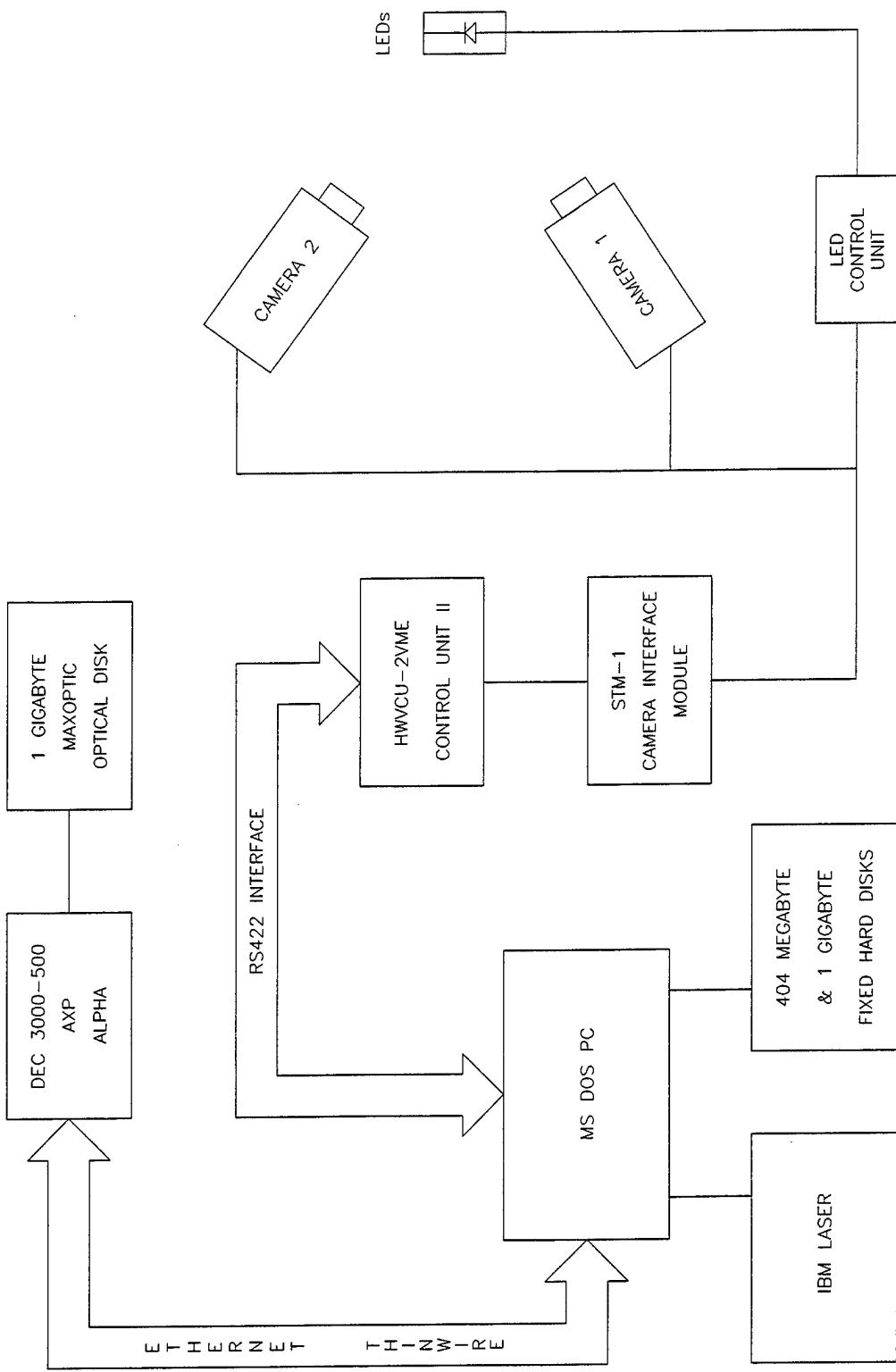


Figure A- 9: Selspot Data Acquisition Block Diagram

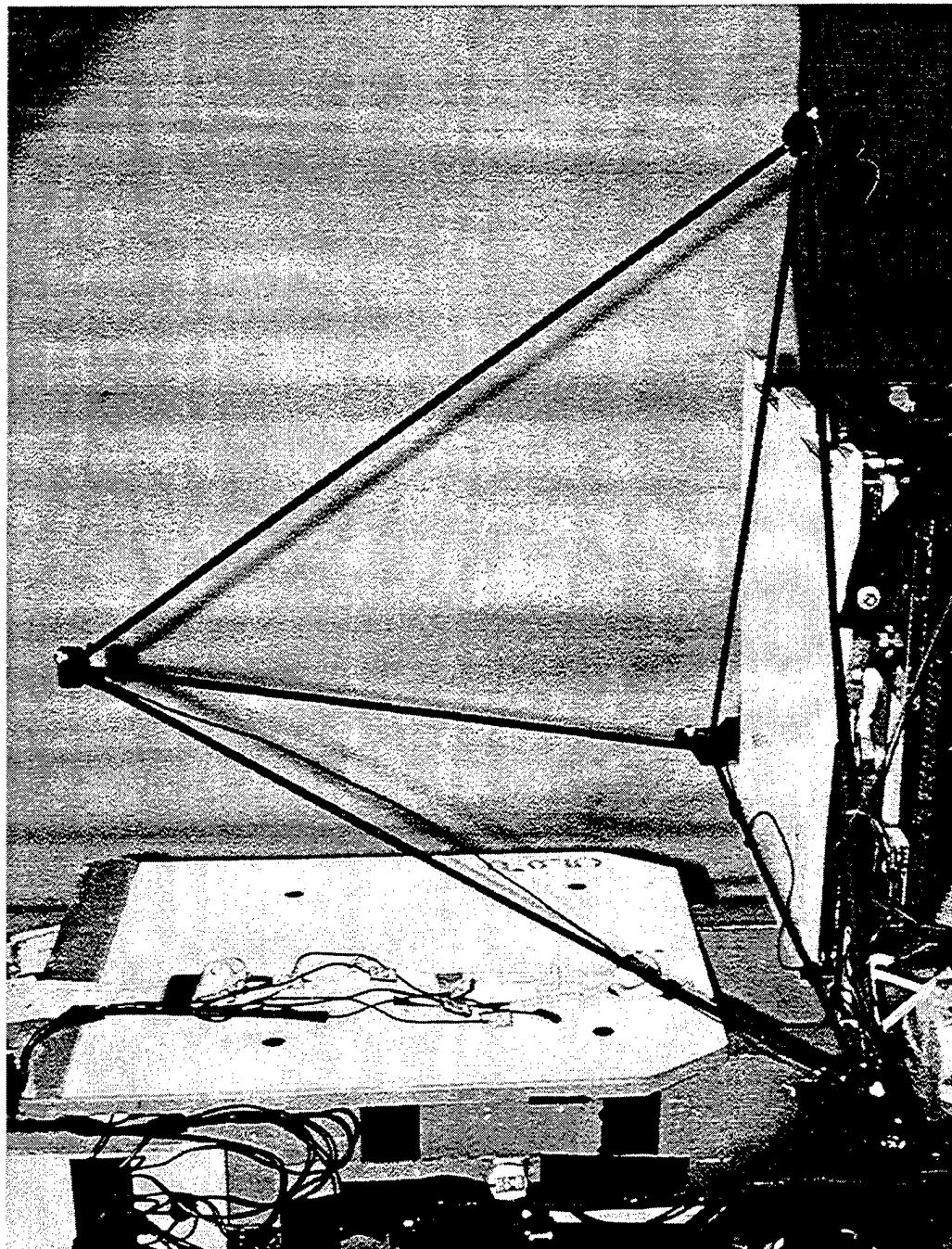
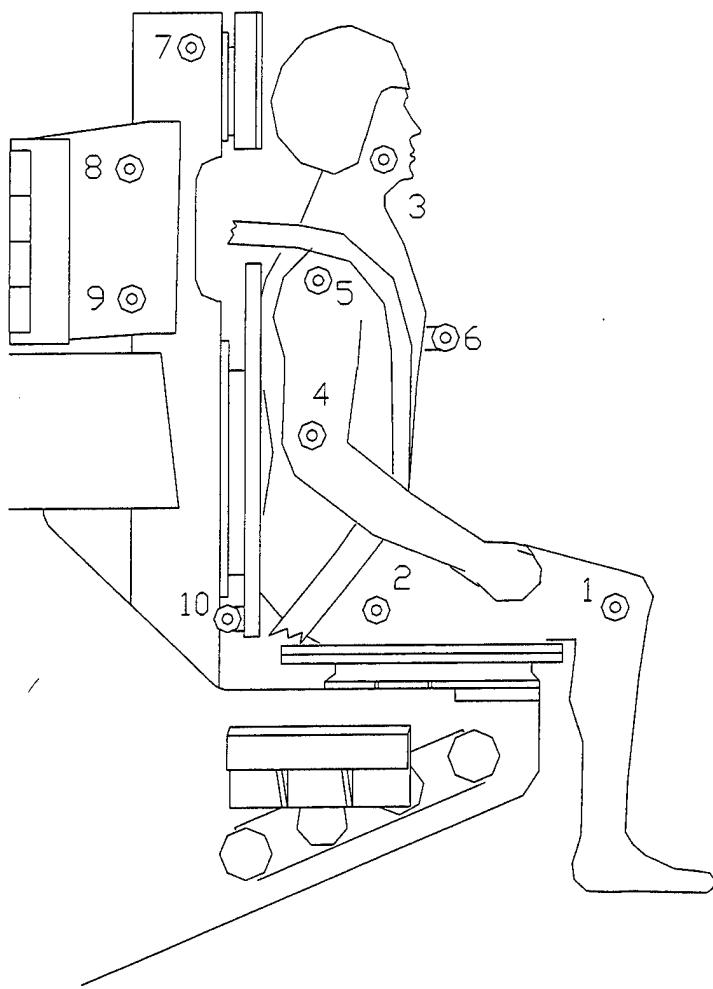


Figure A- 10: Selspot Position Reference Structure



#### LED LOCATIONS

1. Knee
2. Hip
3. Chin
4. Elbow
5. Shoulder
6. Chest
7. Upper Frame
8. Upper Number Plate
9. Lower Number Plate
10. Lower Frame

Figure A- 11: Selspot LED Target Locations

## **APPENDIX B**

### **SAMPLE ACCELERATION/FORCE DATA**

JMB STUDY TEST: 3834 TEST DATE: 11-JUL-1997 SUBJ: JPAT-L WT: 270.0  
 NOM G: 10.0 CELL: A

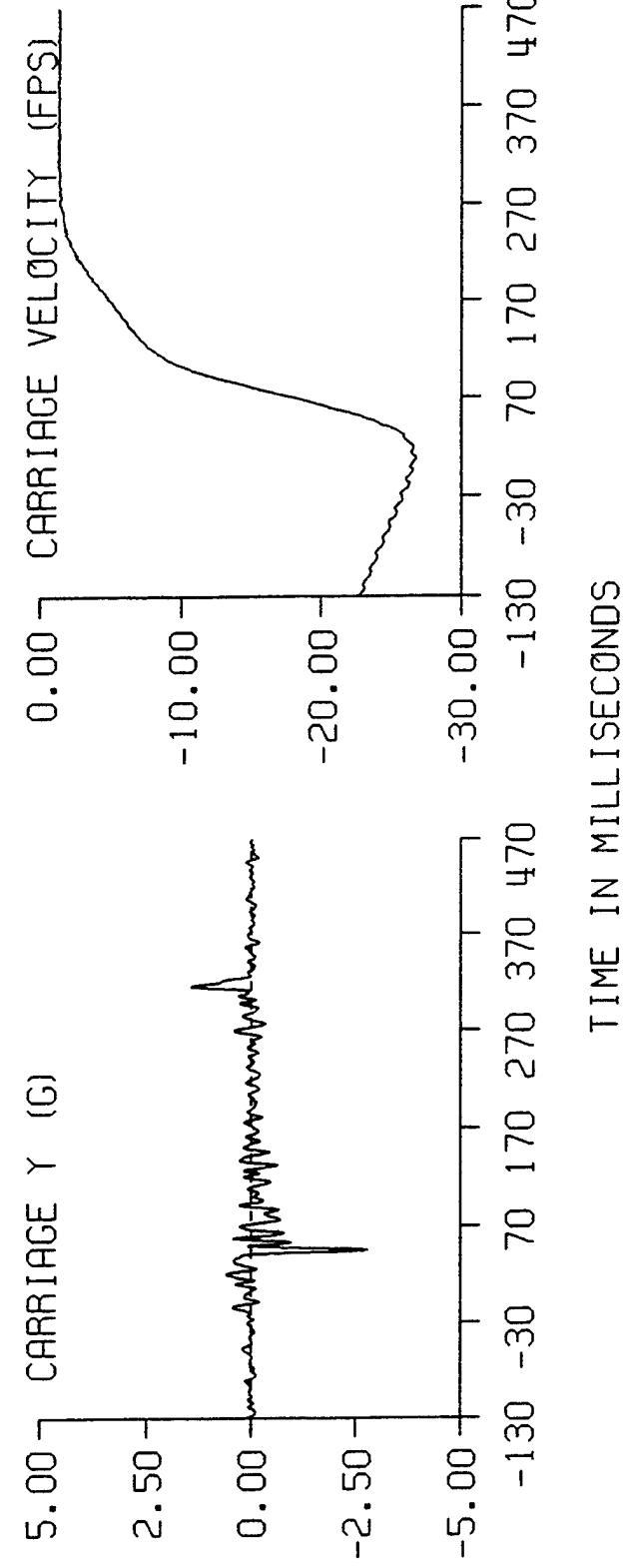
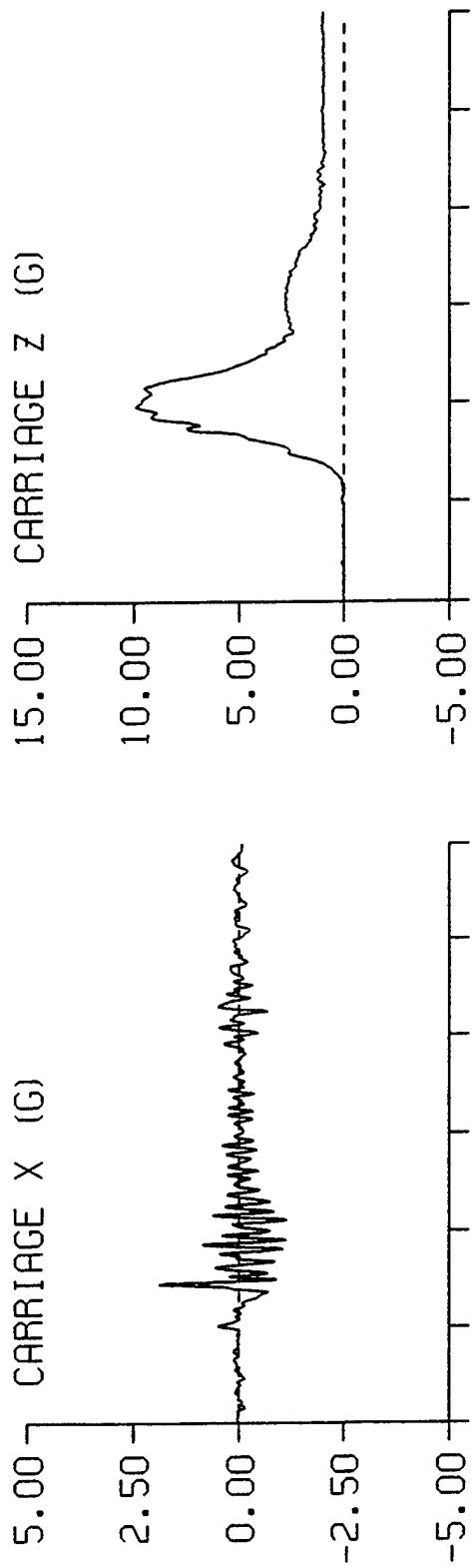
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REFERENCE MARK TIME (MS)				-135.	
CARRIAGE ACCELERATION (G)					
X AXIS	0.08	1.89	-1.15	15.	81.
Y AXIS	0.07	1.43	-2.80	315.	45.
Z AXIS	0.05	9.89	0.44	66.	0.
CARRIAGE VELOCITY (FPS)	-26.13	-1.21	-26.80	310.	7.
SEAT ACCELERATION (G)					
X AXIS	0.07	1.67	-1.10	15.	20.
Y AXIS	0.11	2.06	-2.66	64.	50.
Z AXIS	0.07	11.87	-2.27	55.	313.
EXT CHEST ACCELERATION (G)					
X AXIS	0.10	12.86	-2.63	77.	142.
Y AXIS	0.03	5.48	-5.59	89.	115.
Z AXIS	0.06	16.34	-2.72	94.	340.
RESULTANT	0.14	19.69	0.10	79.	1.
HEADREST FORCES (LB)					
UPPER X AXIS	-2.51	90.08	-13.58	198.	43.
LOWER X AXIS	4.40	88.05	-511.32	200.	194.
X AXIS SUM	1.89	164.26	-500.60	199.	194.
SHOULDER FORCES (LB)					
X AXIS	-12.27	1.89	-166.38	330.	89.
Y AXIS	-0.44	18.81	-22.12	81.	197.
Z AXIS	-4.23	112.43	-7.11	81.	340.
RESULTANT	13.14	199.13	1.10	89.	318.
LAP FORCES (LB)					
LEFT X AXIS	-15.89	4.77	-185.87	56.	186.
LEFT Y AXIS	2.51	34.27	-6.39	178.	128.
LEFT Z AXIS	-30.43	13.44	-234.91	57.	185.
LEFT RESULTANT	34.44	301.34	1.13	186.	35.
RIGHT X AXIS	-12.84	4.10	-134.01	66.	201.
RIGHT Y AXIS	-7.93	5.80	-63.85	63.	201.
RIGHT Z AXIS	-29.48	12.38	-191.95	65.	201.
RIGHT RESULTANT	33.13	242.65	0.81	201.	107.

JMB STUDY TEST: 3834 TEST DATE: 11-JUL-1997 SUBJ: JPAT-L WT: 270.0  
NOM G: 10.0 CELL: A

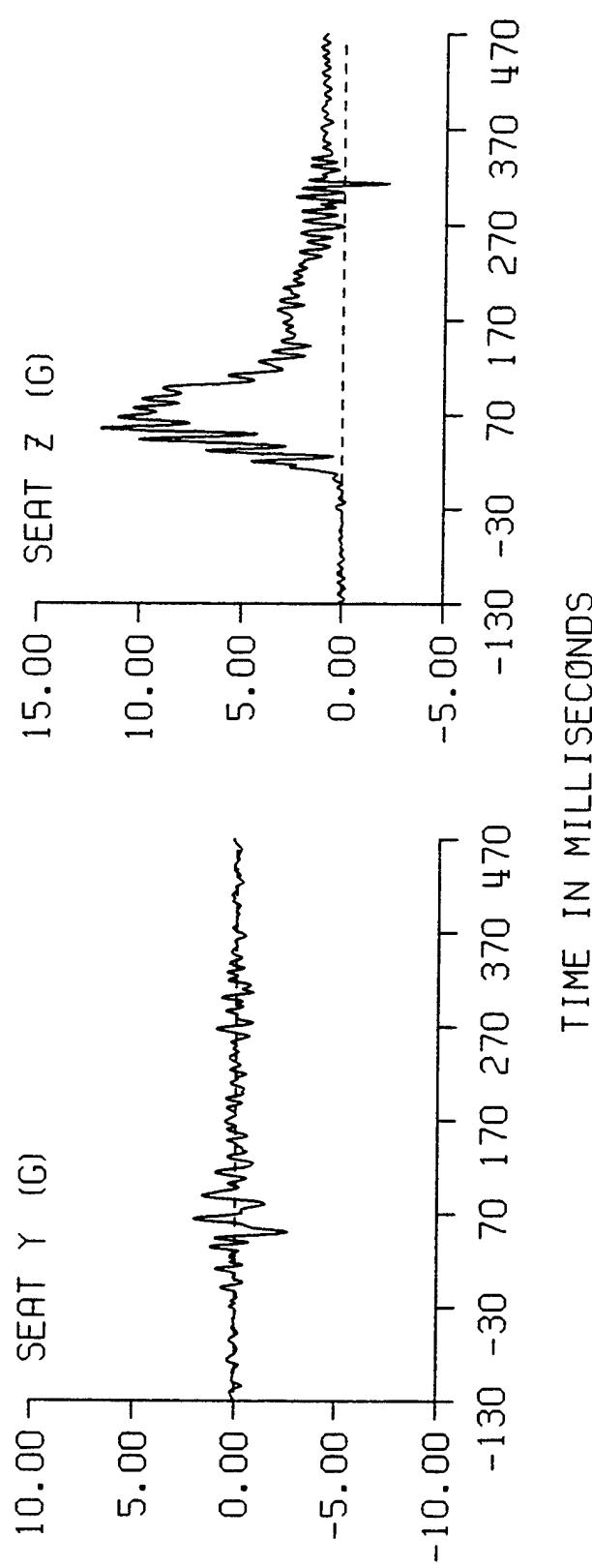
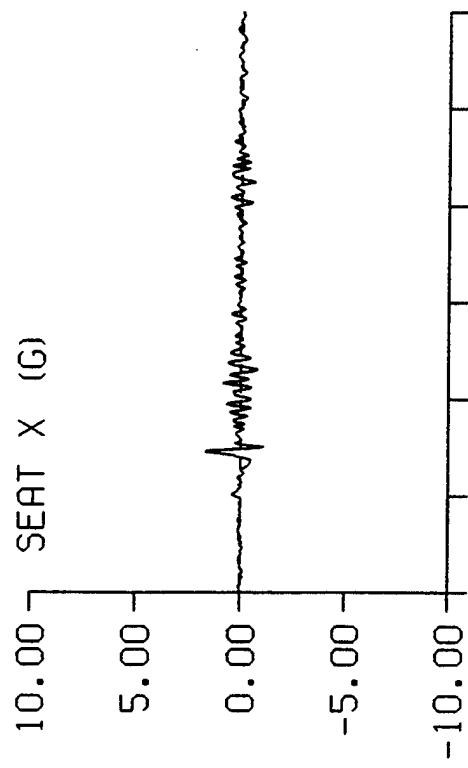
DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
SEAT FORCES (LB)					
LEFT X AXIS	-36.90	179.73	-135.48	272.	54.
RIGHT X AXIS	-25.05	22.19	-199.72	278.	101.
X AXIS SUM	-61.95	153.09	-244.38	279.	125.
Y AXIS	12.11	226.65	-106.81	108.	179.
LEFT Z AXIS	20.89	1159.85	16.68	105.	7.
RIGHT Z AXIS	20.20	1735.20	11.57	98.	0.
CENTER Z AXIS	-20.73	2043.07	-36.42	78.	197.
Z AXIS SUM	20.36	3845.87	22.33	95.	0.
RESULTANT	66.65	3852.72	76.00	95.	16.
Z SUM MINUS TARE	44.75	3677.16	16.86	96.	26.
RESULTANT MINUS TARE	77.61	3684.32	57.14	96.	16.

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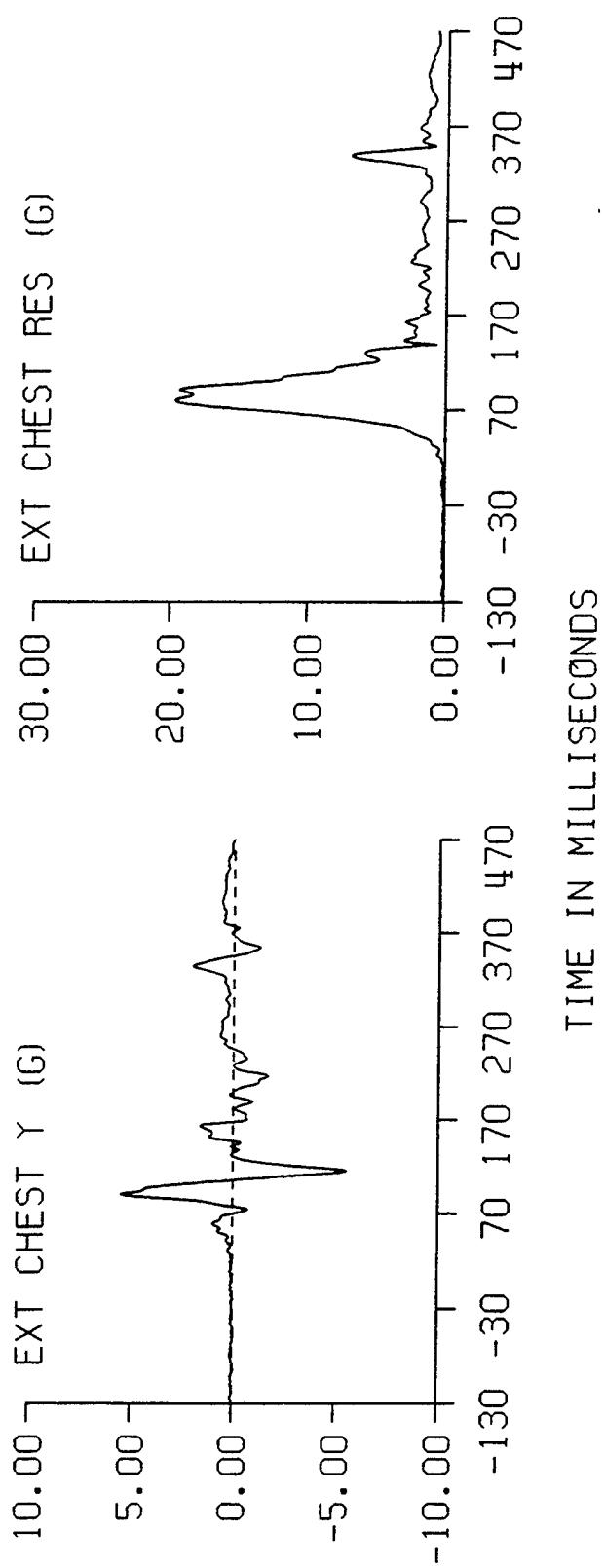
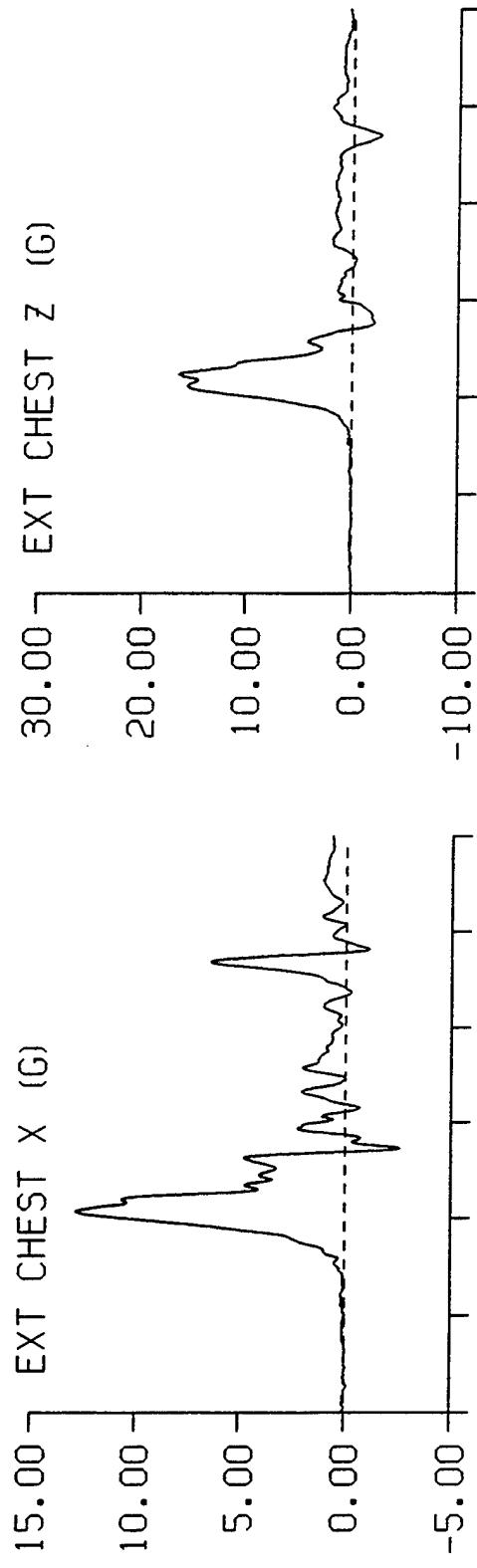
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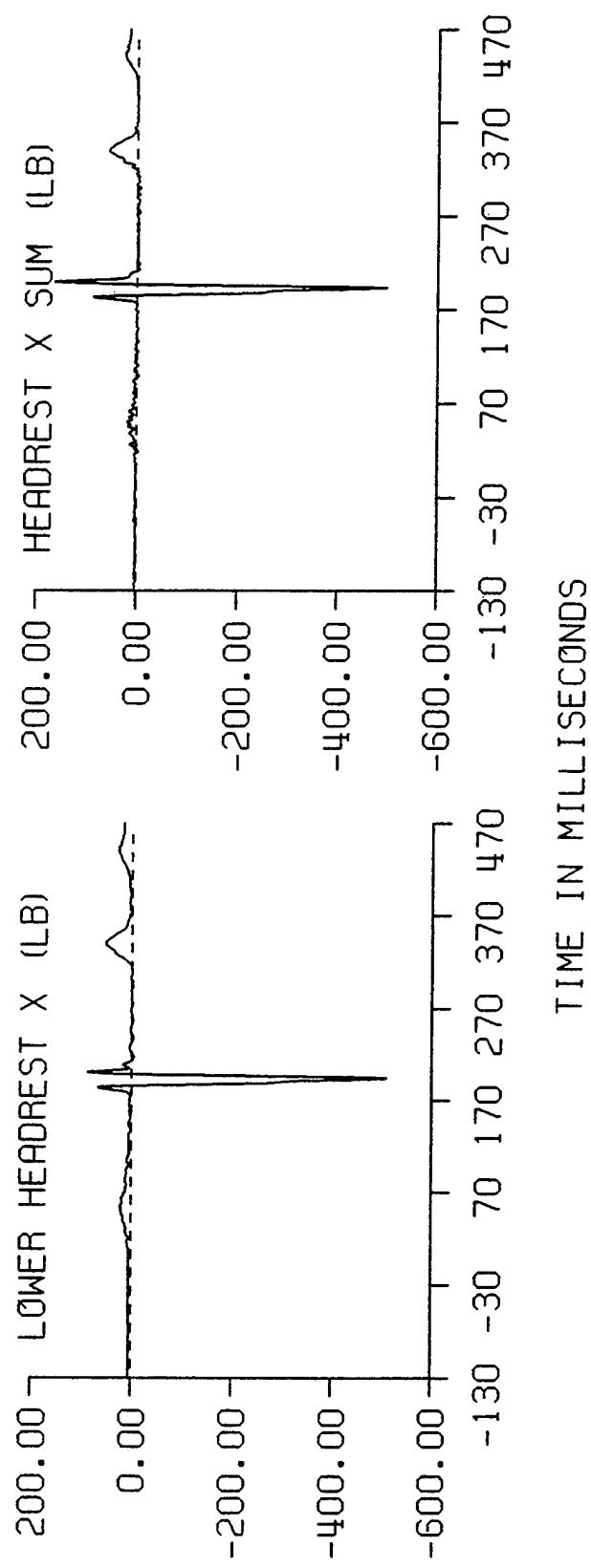
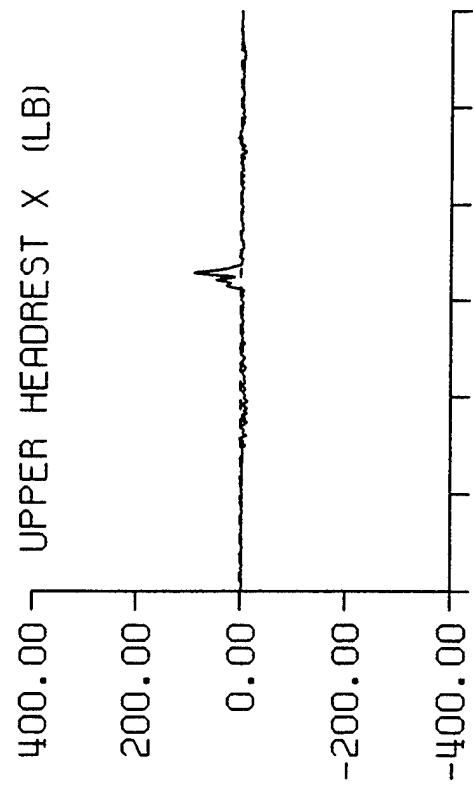
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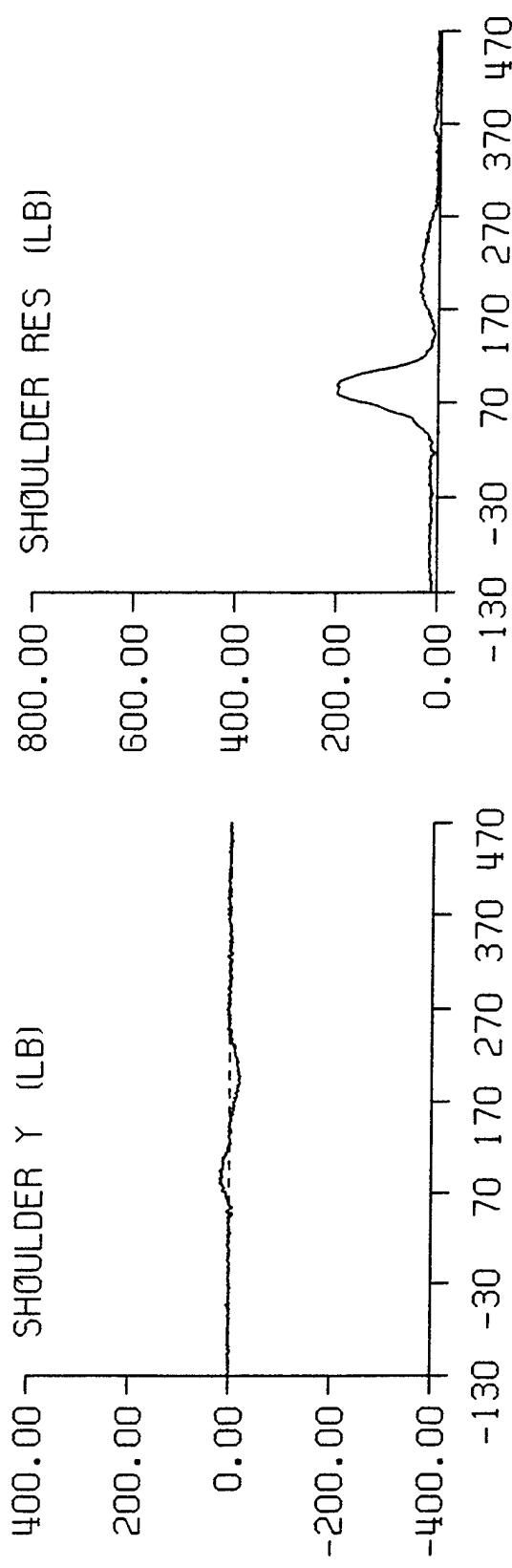
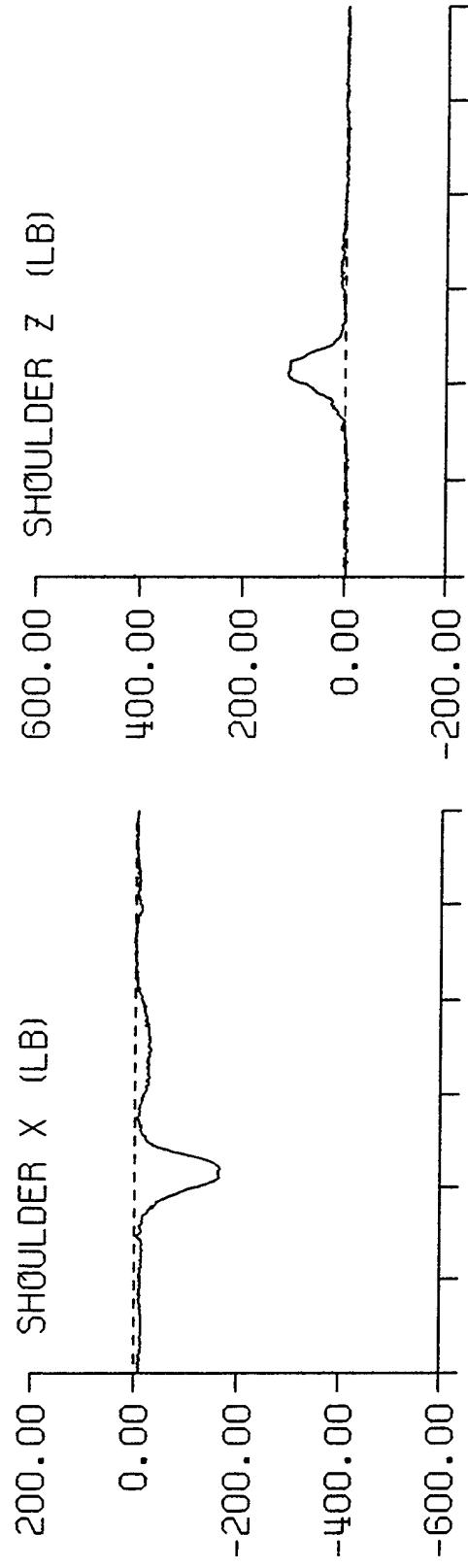
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JMB STUDY TEST: 3834 SUBJ: JPAT-L CELL: A

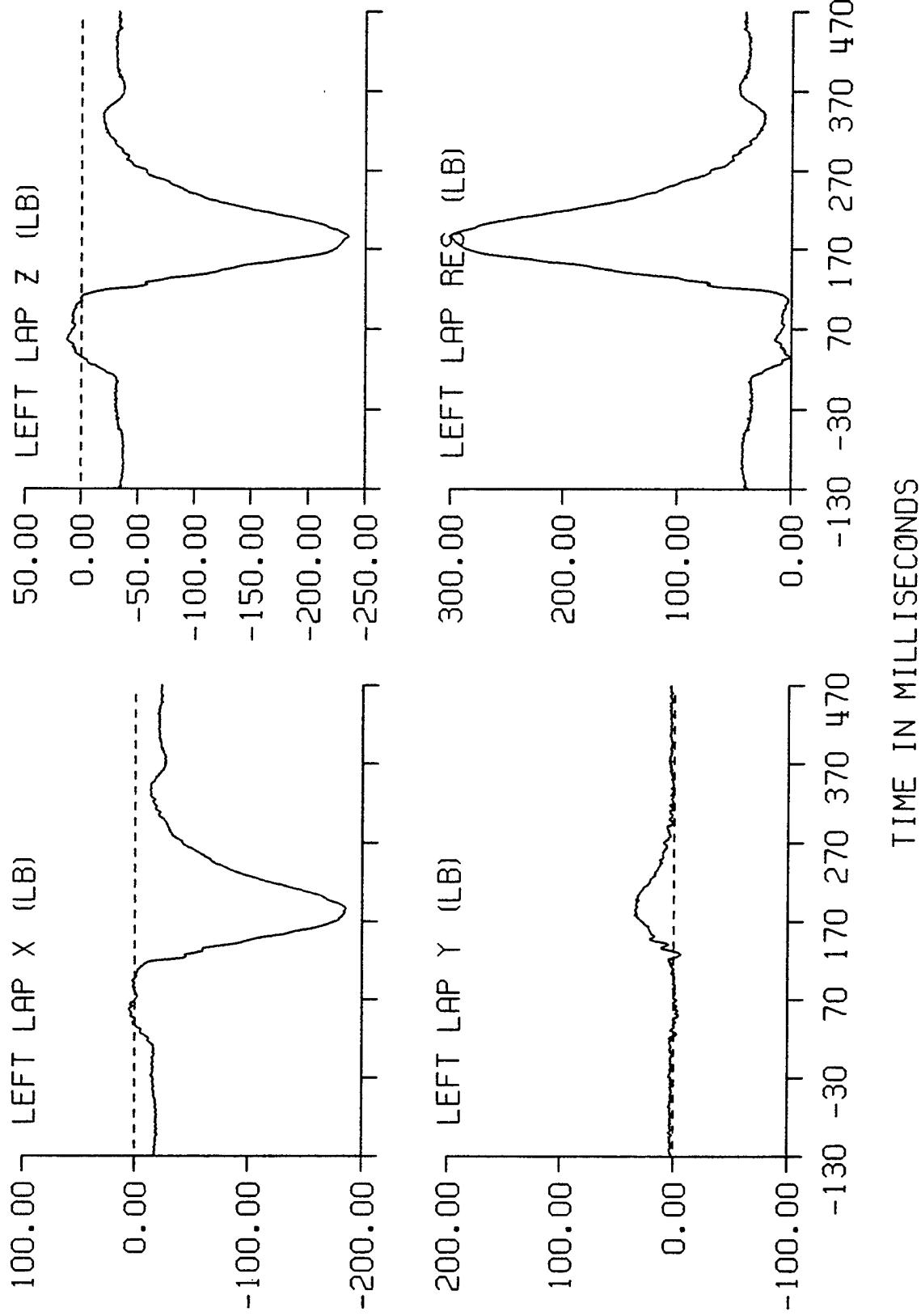


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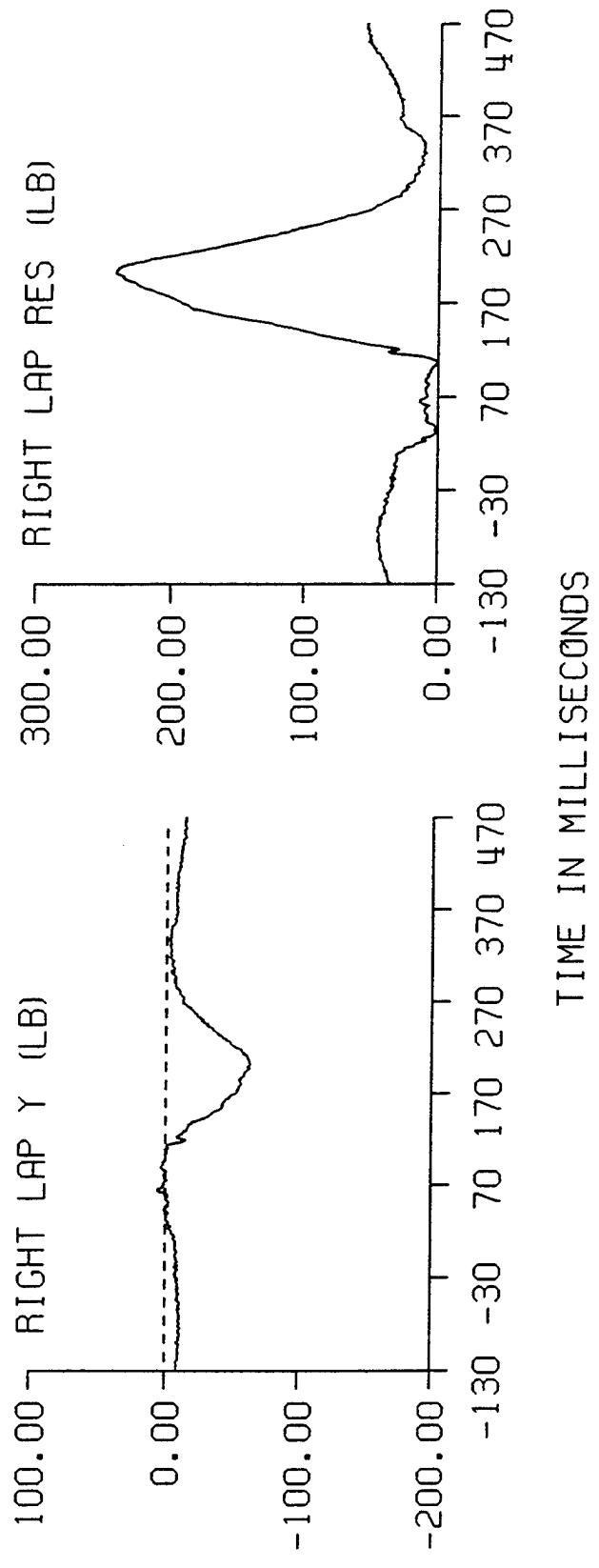
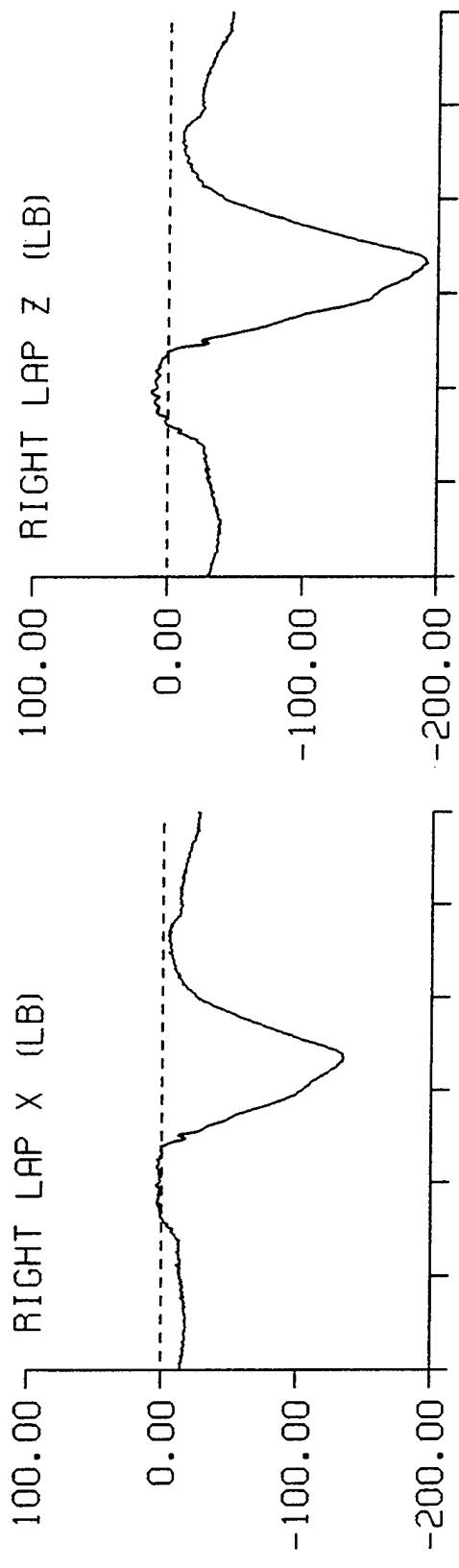


TIME IN MILLISECONDS

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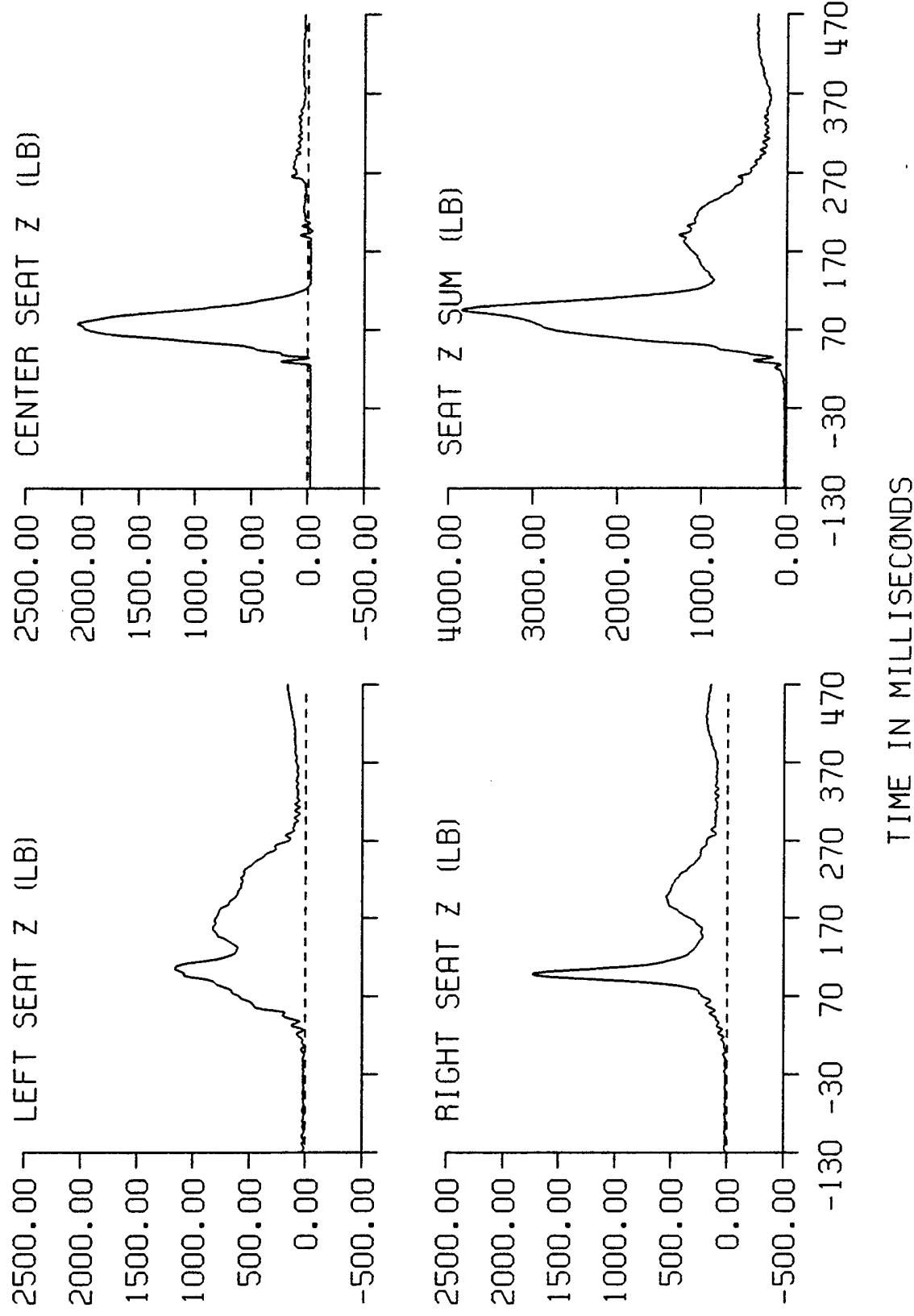


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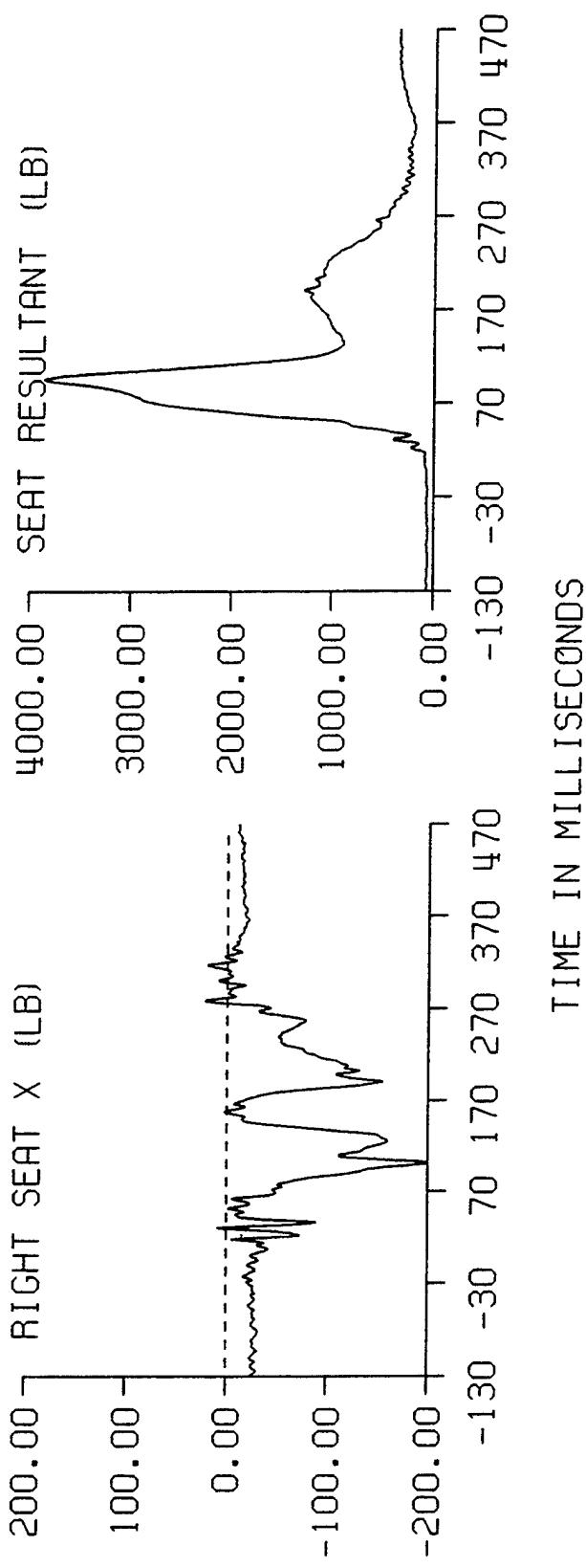
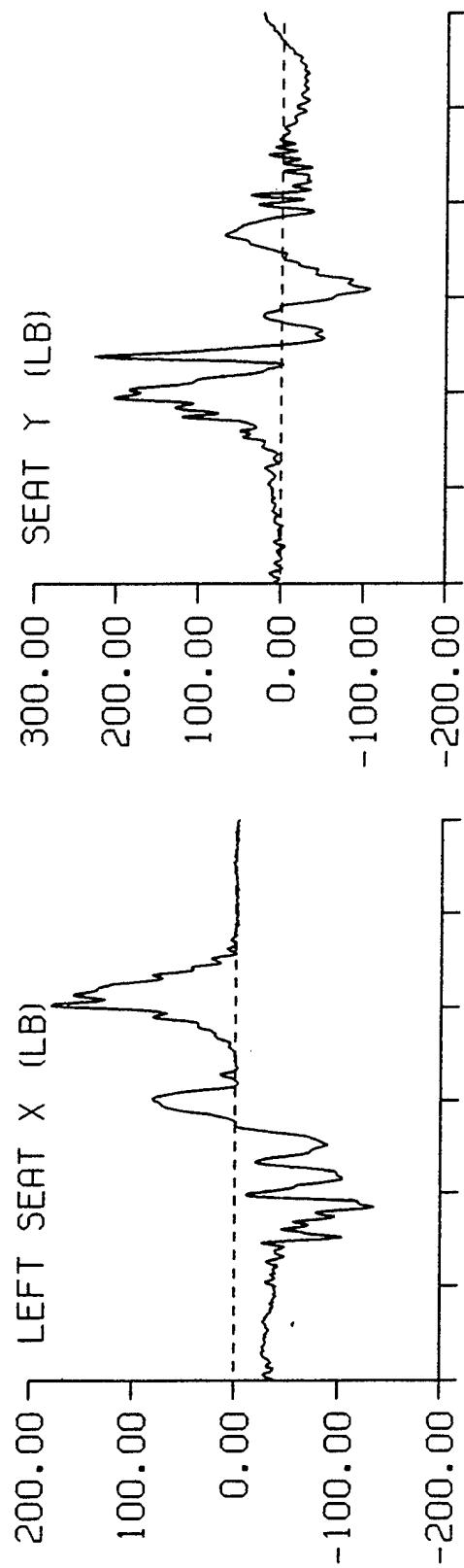


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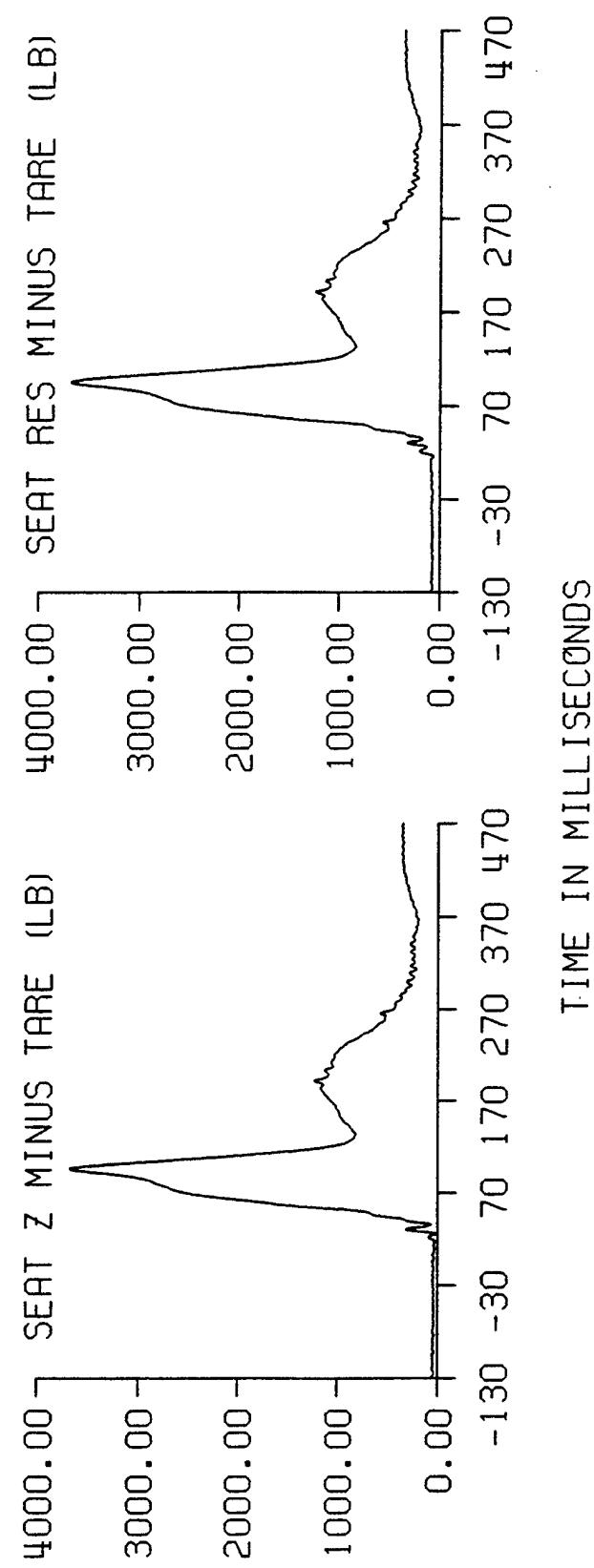
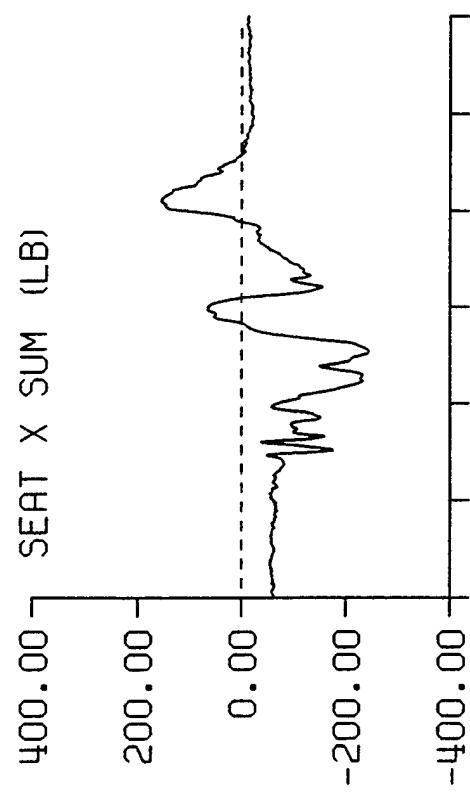
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JMB STUDY TEST: 3834 SUBJ: JPAT-L CELL: A



JMB STUDY TEST: 3834 SUBJ: JPAT-L CELL: A



JMB STUDY TEST: 3838 TEST DATE: 12-JUL-1997 SUBJ: JPAT-L WT: 270.0  
NOM G: 10.0 CELL: B

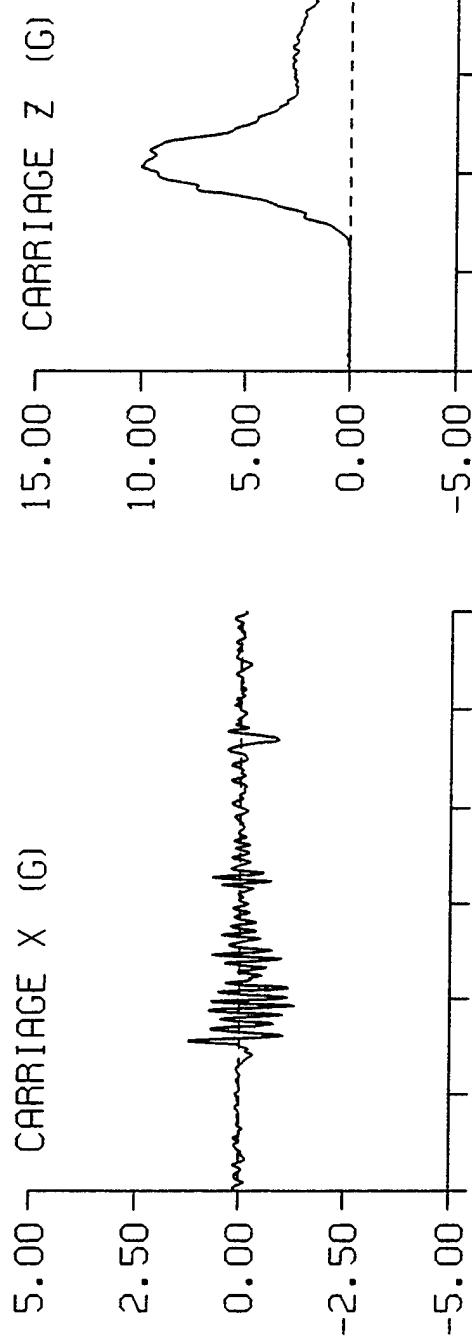
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CARRIAGE ACCELERATION (G)					
X AXIS	0.01	1.22	-1.34	16.	52.
Y AXIS	0.00	1.30	-2.52	332.	49.
Z AXIS	0.03	10.00	0.46	66.	0.
CARRIAGE VELOCITY (FPS)	-26.39	-1.23	-27.09	340.	12.
SEAT ACCELERATION (G)					
X AXIS	0.01	1.13	-1.27	48.	102.
Y AXIS	0.02	1.65	-2.64	68.	55.
Z AXIS	0.02	11.24	-1.03	69.	331.
EXT CHEST ACCELERATION (G)					
X AXIS	-0.02	14.82	-1.95	88.	150.
Y AXIS	0.00	2.26	-2.48	211.	124.
Z AXIS	0.03	13.79	-3.14	86.	163.
RESULTANT	0.05	20.17	0.04	86.	0.
HEADREST FORCES (LB)					
UPPER X AXIS	-0.96	93.54	-10.61	191.	58.
LOWER X AXIS	-4.73	118.45	-5.97	184.	234.
X AXIS SUM	-5.69	208.02	-8.16	184.	15.
SHOULDER FORCES (LB)					
X AXIS	-18.13	-0.29	-198.43	301.	90.
Y AXIS	-7.29	18.75	-11.01	98.	15.
Z AXIS	-6.58	122.78	-8.91	87.	10.
RESULTANT	20.71	231.62	3.53	90.	157.
LAP FORCES (LB)					
LEFT X AXIS	-26.41	2.37	-135.82	55.	201.
LEFT Y AXIS	3.12	27.74	-7.00	194.	53.
LEFT Z AXIS	-54.82	11.06	-221.18	68.	203.
LEFT RESULTANT	60.94	260.96	2.08	203.	40.
RIGHT X AXIS	-25.39	2.68	-140.34	56.	203.
RIGHT Y AXIS	-14.49	2.35	-73.90	61.	201.
RIGHT Z AXIS	-48.66	10.72	-212.52	64.	201.
RIGHT RESULTANT	56.77	264.81	2.28	201.	37.

JMB STUDY TEST: 3838 TEST DATE: 12-JUL-1997 SUBJ: JPAT-L WT: 270.0  
NOM G: 10.0 CELL: B

DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
SEAT FORCES (LB)					
LEFT X AXIS	-57.42	180.79	-190.70	154.	91.
RIGHT X AXIS	-15.44	69.21	-195.74	58.	151.
X AXIS SUM	-72.86	3.92	-326.29	259.	174.
Y AXIS	1.89	200.26	-154.27	66.	154.
LEFT Z AXIS	28.96	1703.45	25.17	102.	7.
RIGHT Z AXIS	13.14	1886.02	15.91	101.	0.
CENTER Z AXIS	-10.91	1921.95	-50.19	76.	181.
Z AXIS SUM	31.18	4250.81	41.12	100.	2.
RESULTANT	79.41	4257.78	85.57	100.	1.
Z SUM MINUS TARE	56.26	4121.78	42.55	100.	22.
RESULTANT MINUS TARE	92.18	4128.97	86.54	100.	22.

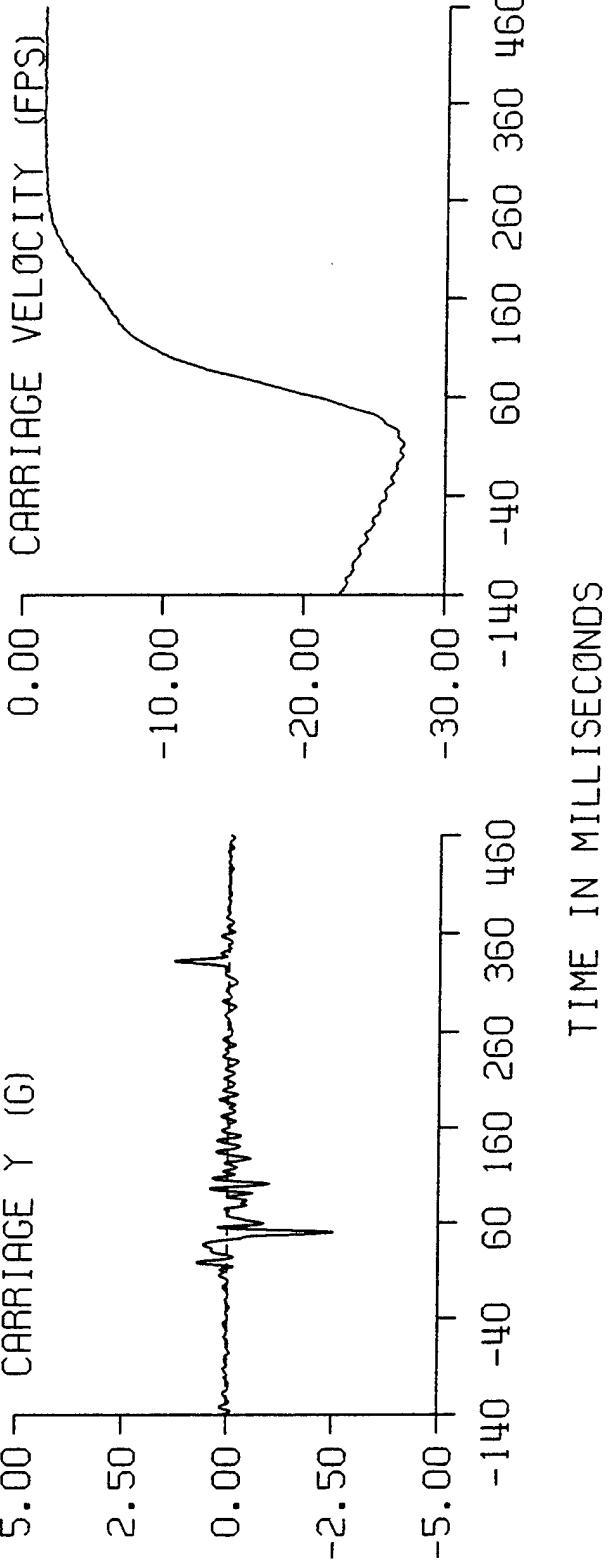
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JMB STUDY TEST: 3838 SUBJ: JPAT-L CELL: B

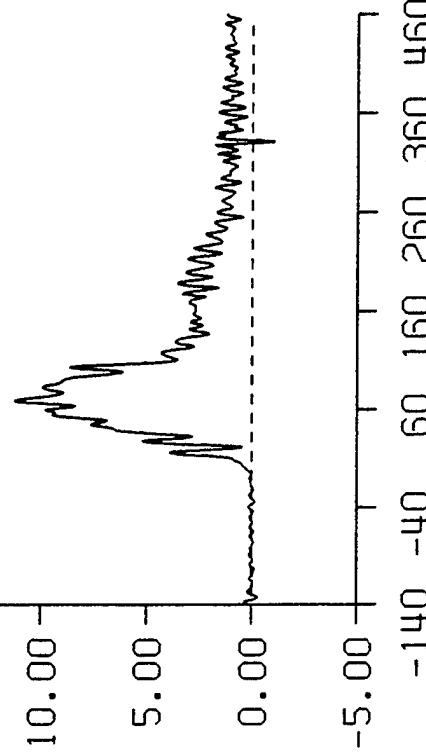
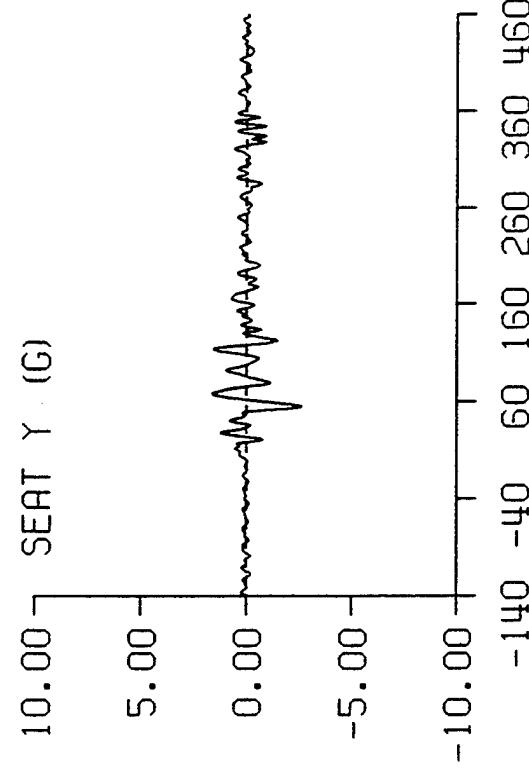
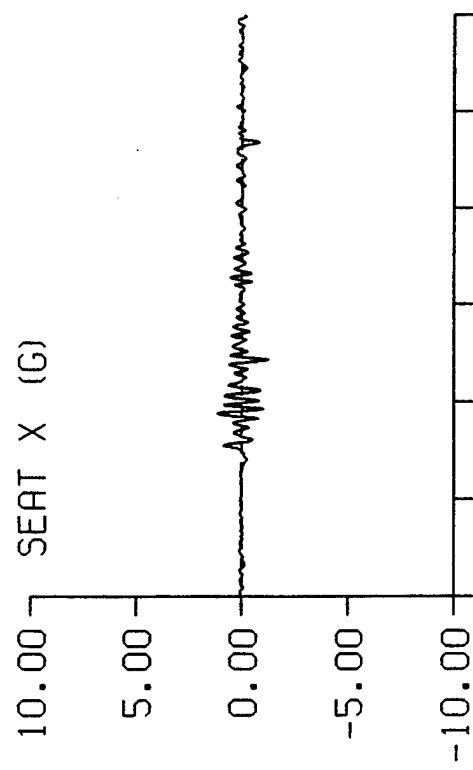


B-15

58

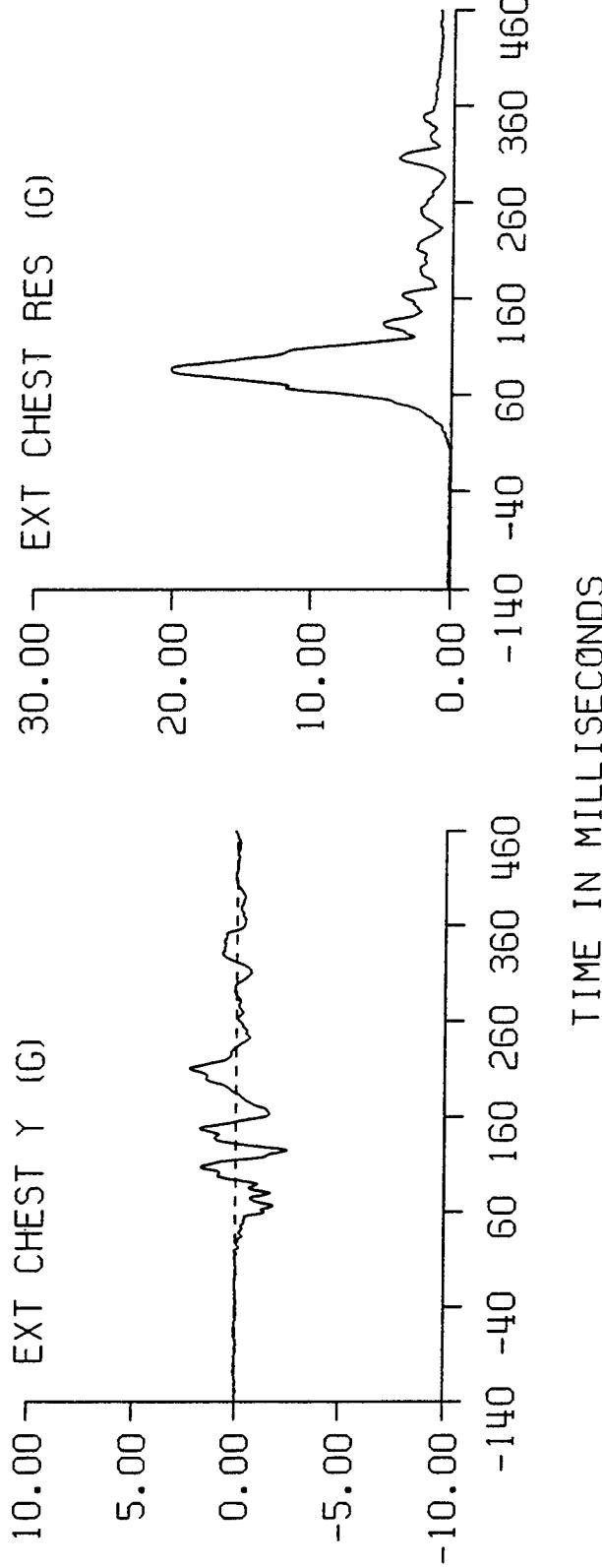
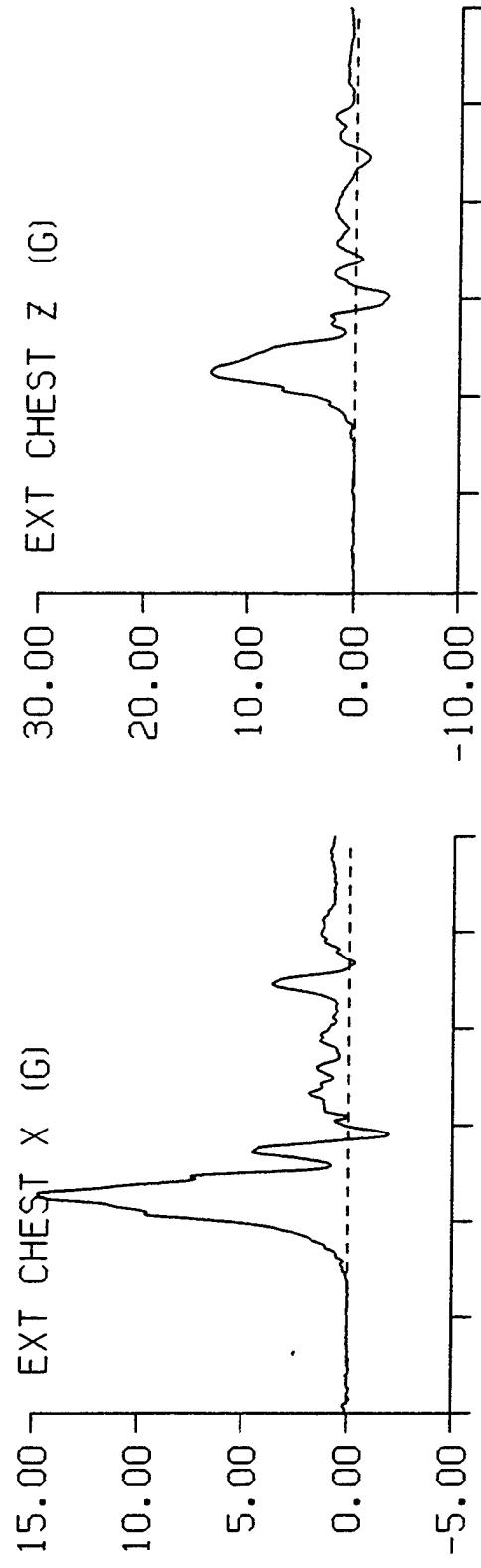


JMB STUDY TEST: 3838 SUBJ: JPAT-L CELL: B

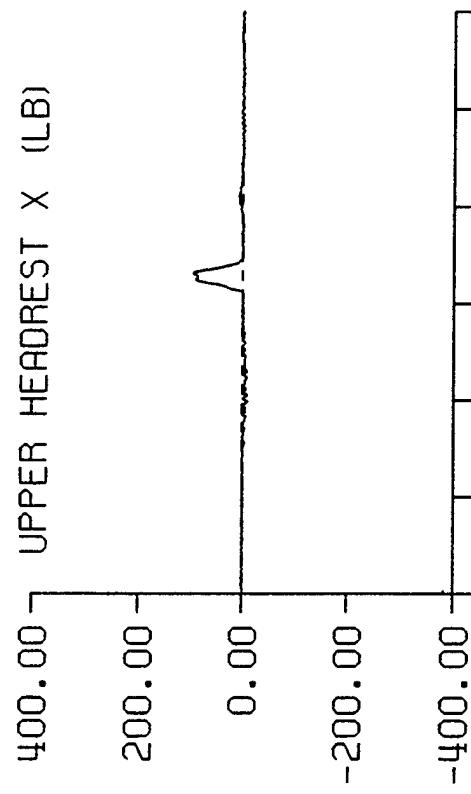


TIME IN MILLISECONDS

JMB STUDY TEST: 3838 SUBJ: JPAT-L CELL: B



JMB STUDY TEST: 3838 SUBJ: JPAT-L CELL: B



B-18

61

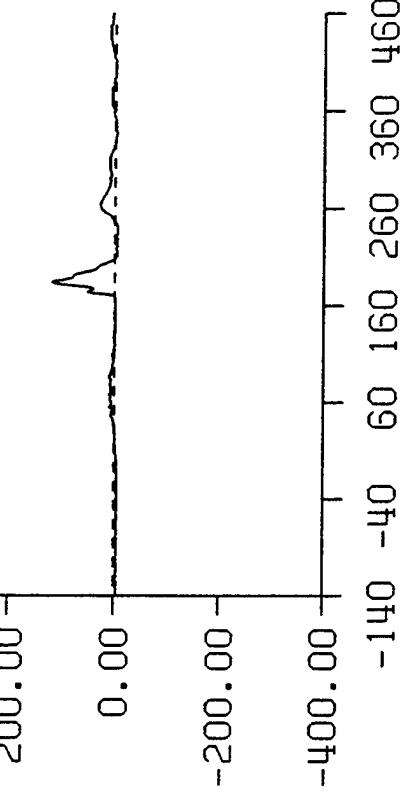
400.00    HEADREST X SUM (LB)

200.00

0.00

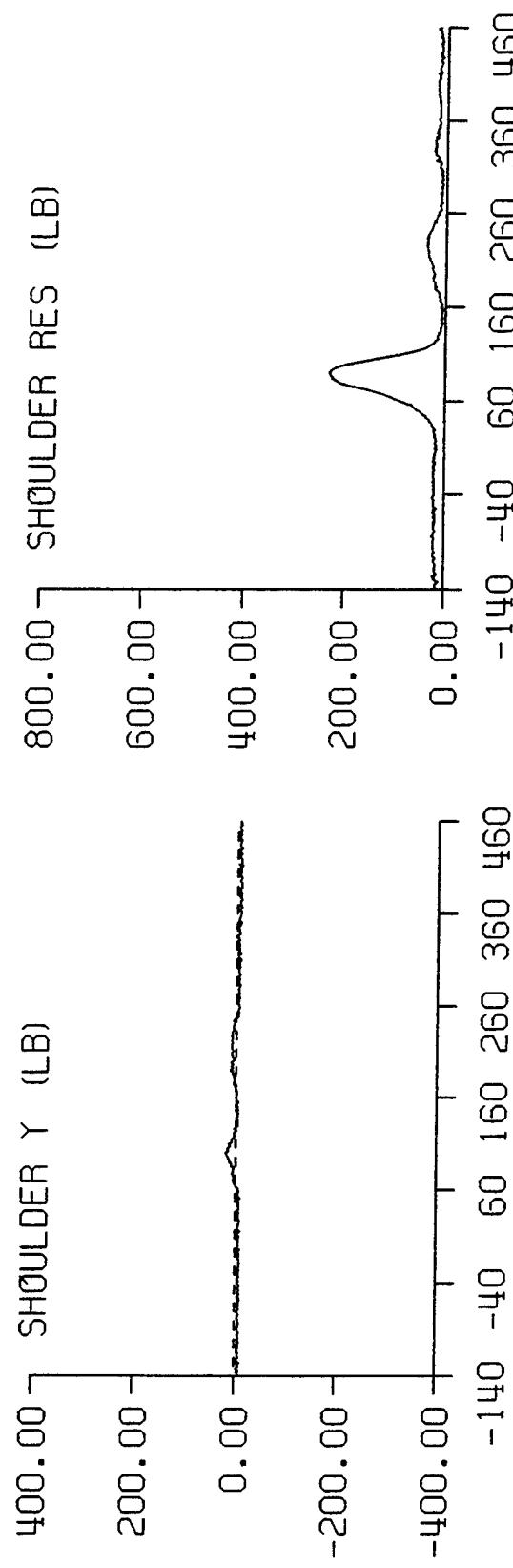
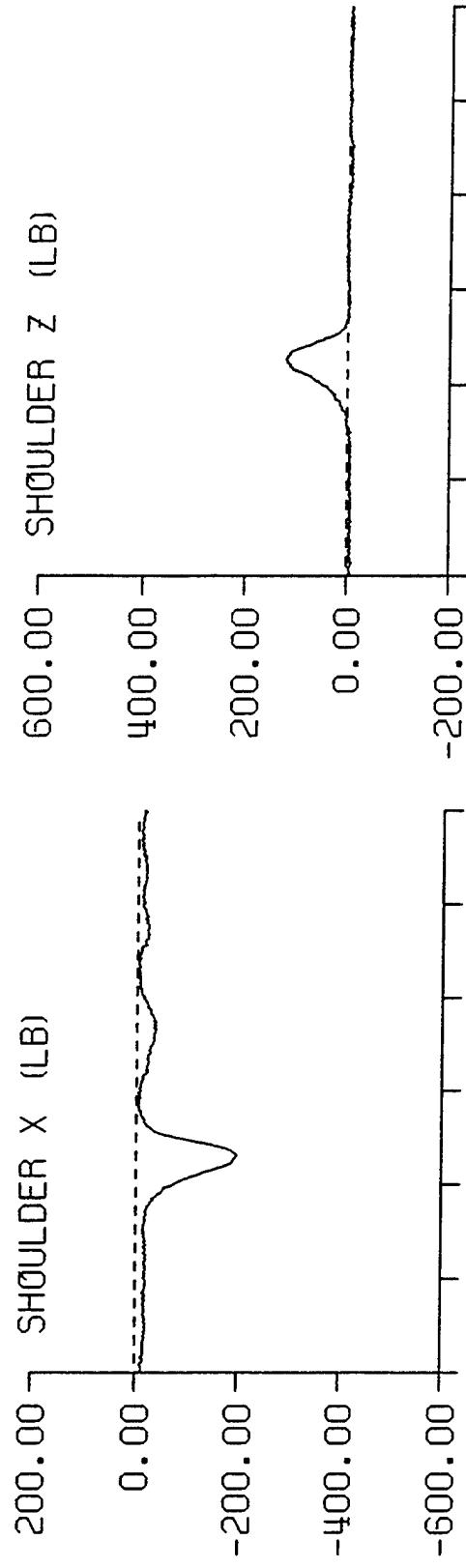
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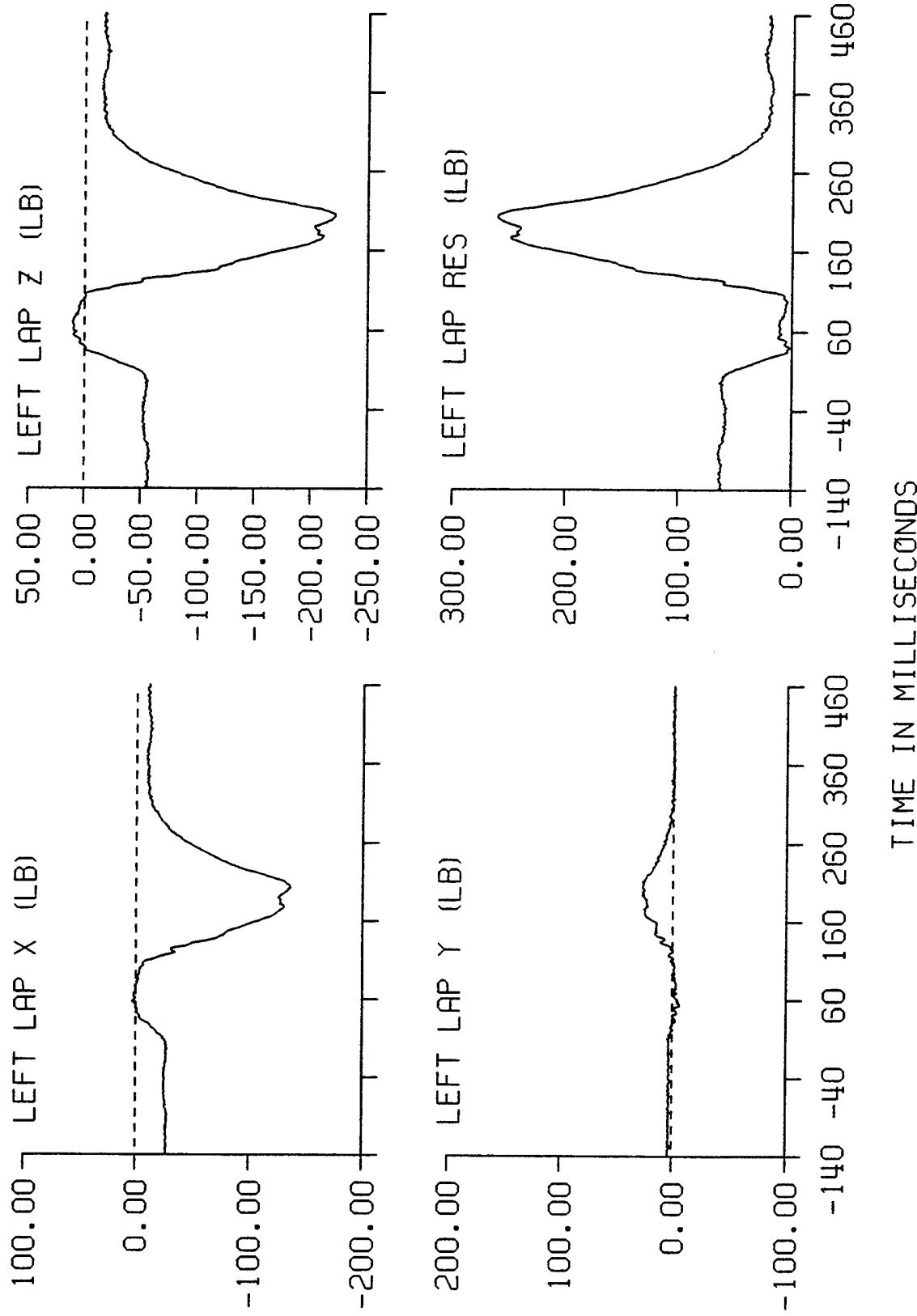
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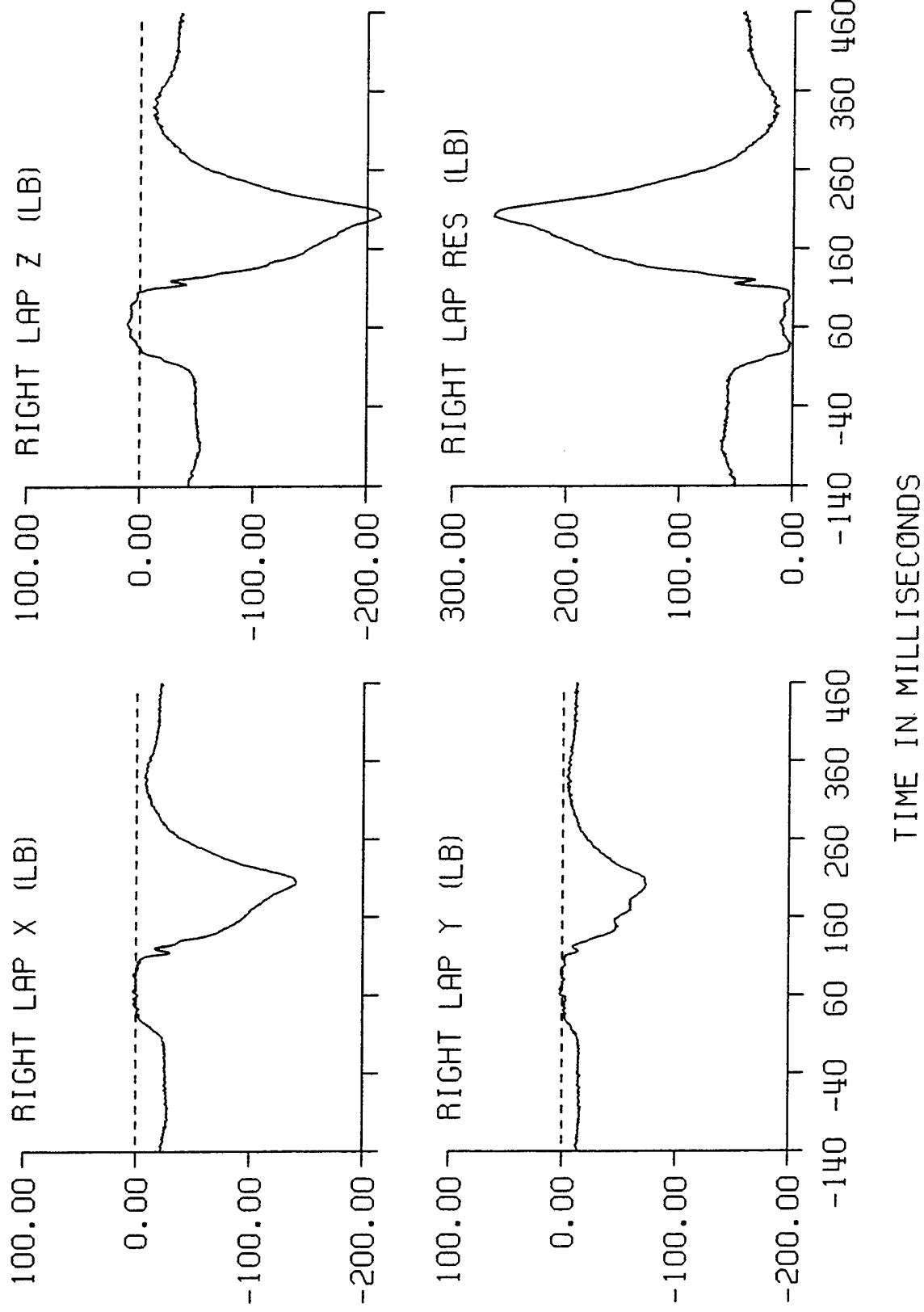


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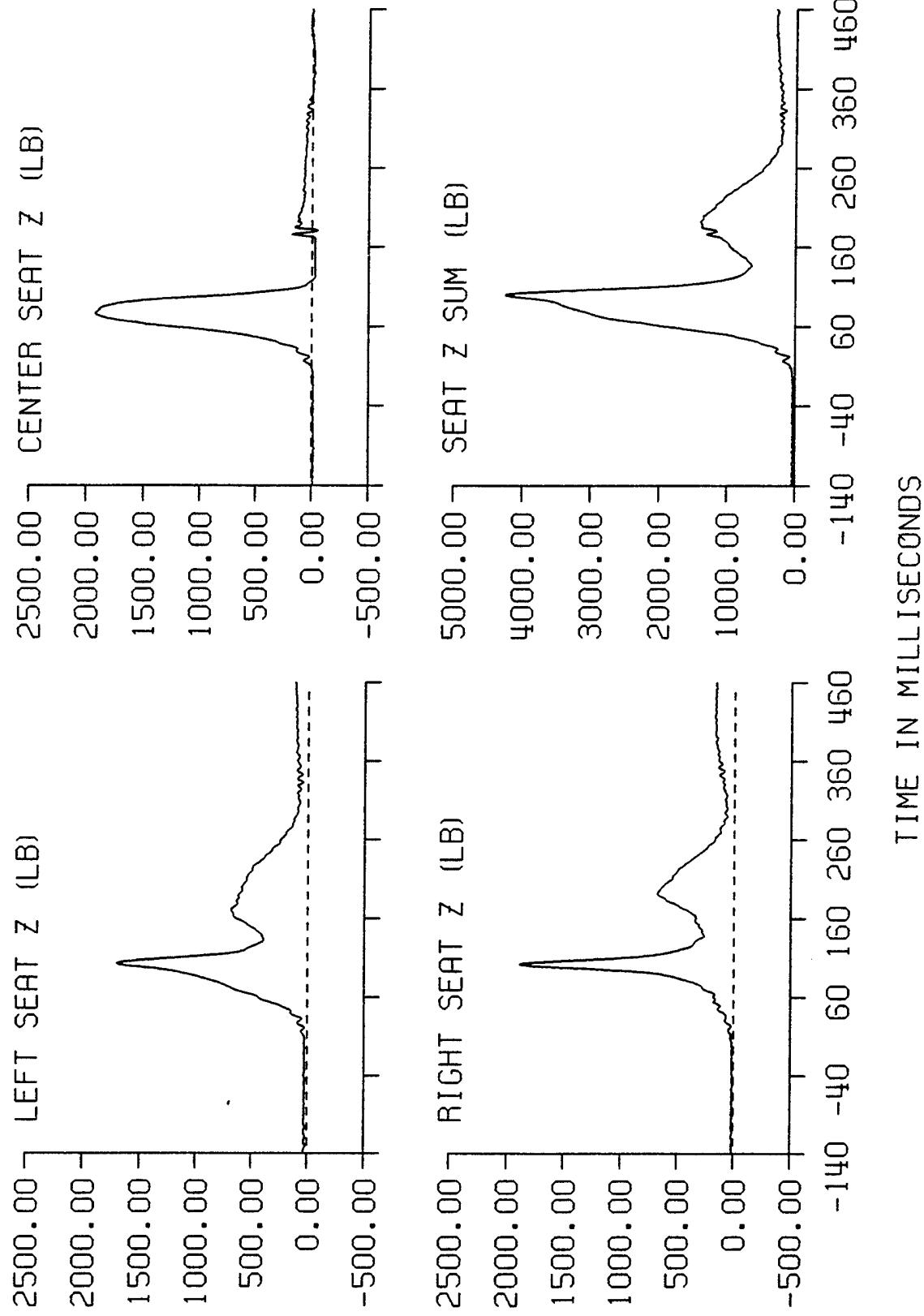
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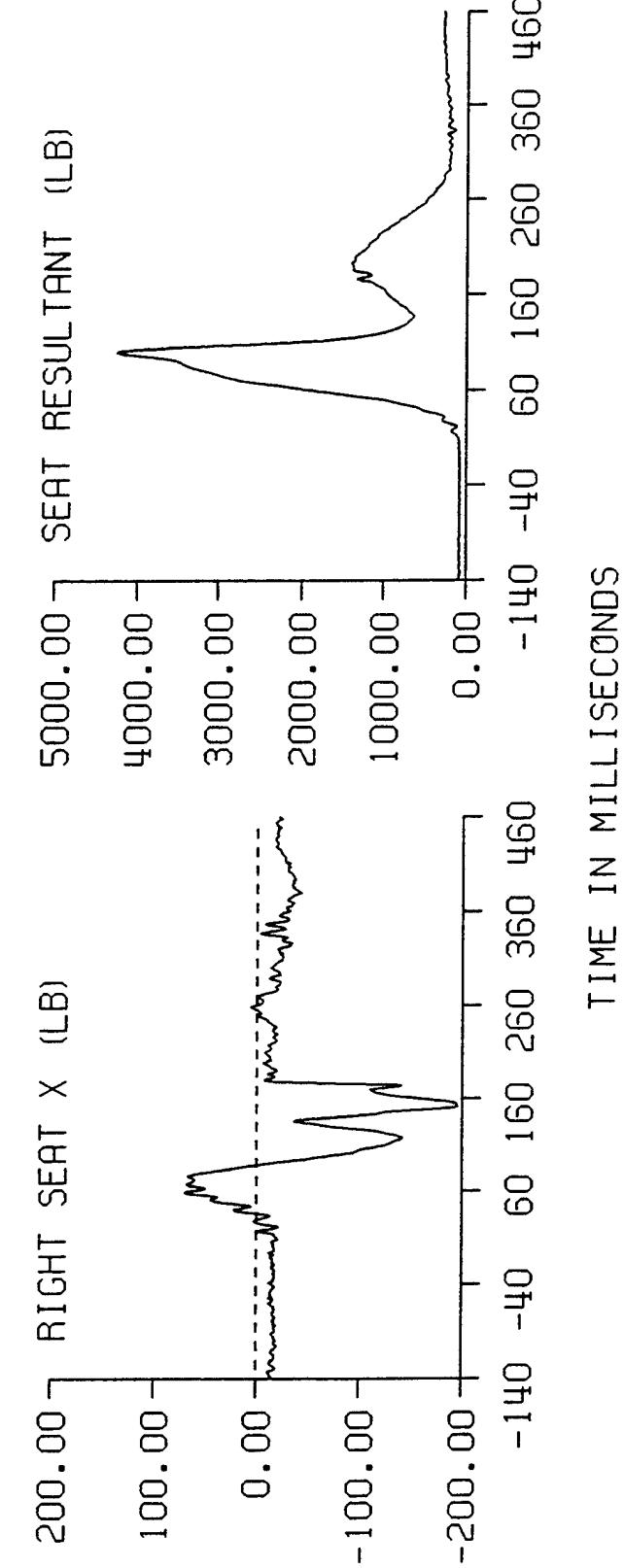
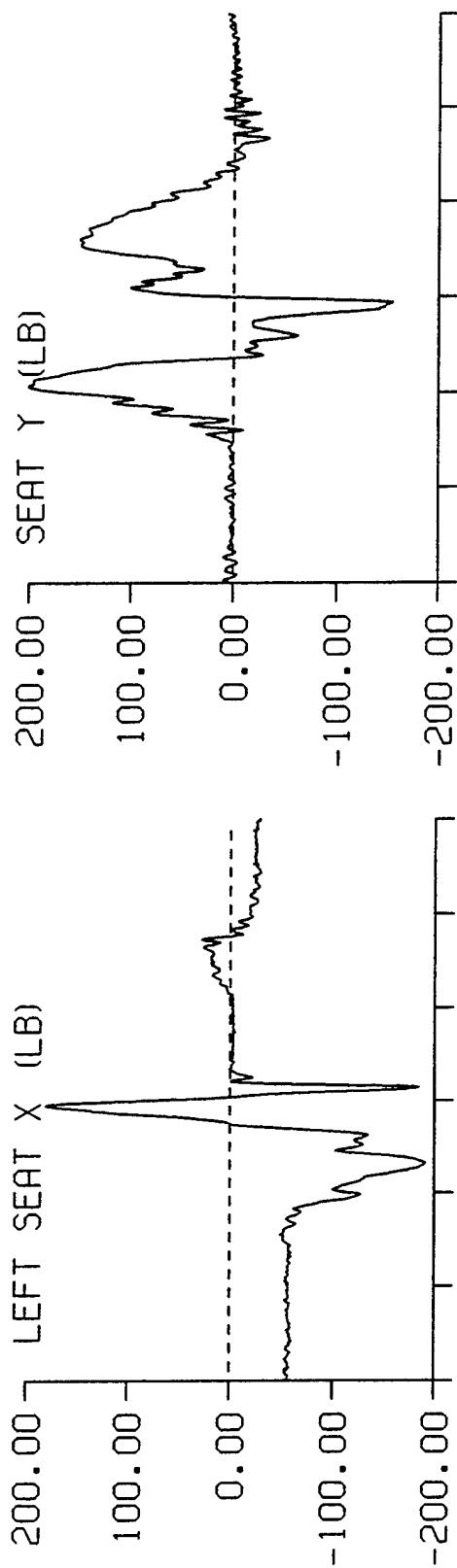
JMB STUDY TEST: 3838 SUBJ: JPAT-L CELL: B



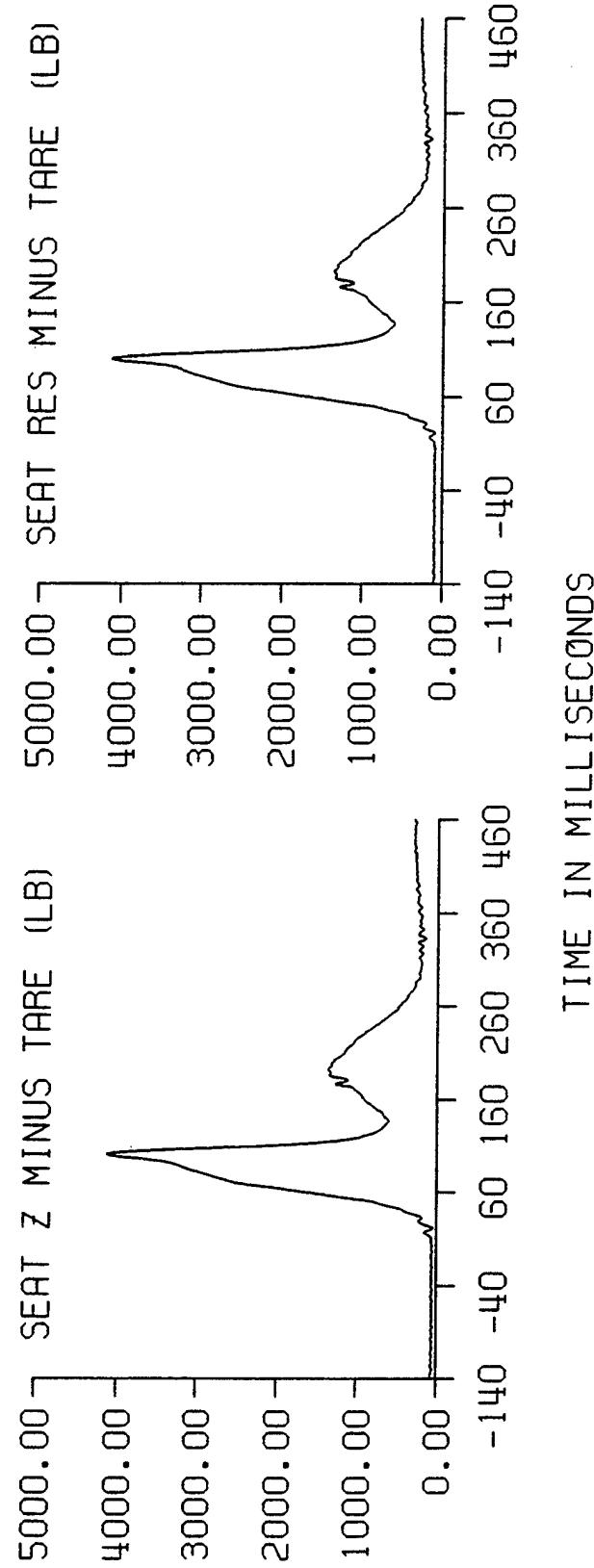
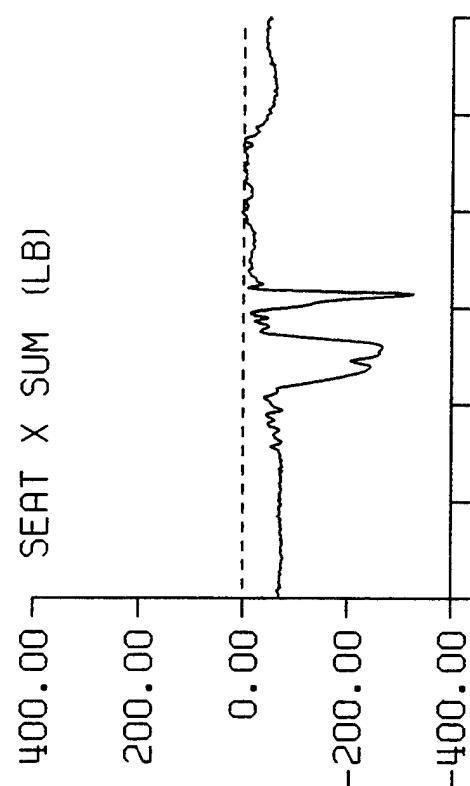
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JMB STUDY TEST: 3838 SUBJ: JPAT-L CELL: B



JMB STUDY TEST: 3838 SUBJ: JPAT-L CELL: B



JMB STUDY TEST: 3842 TEST DATE: 13-JUL-1997 SUBJ: CG-98 WT: 267.0  
 NOM G: 10.0 CELL: B

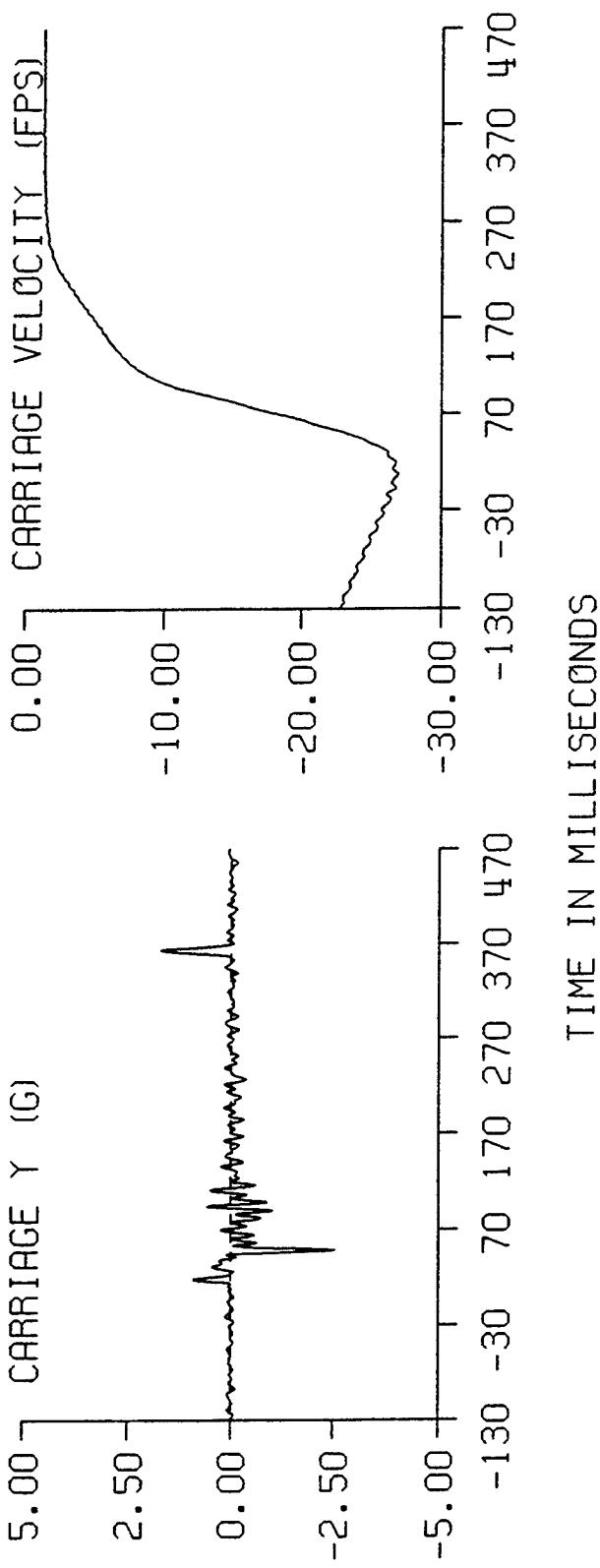
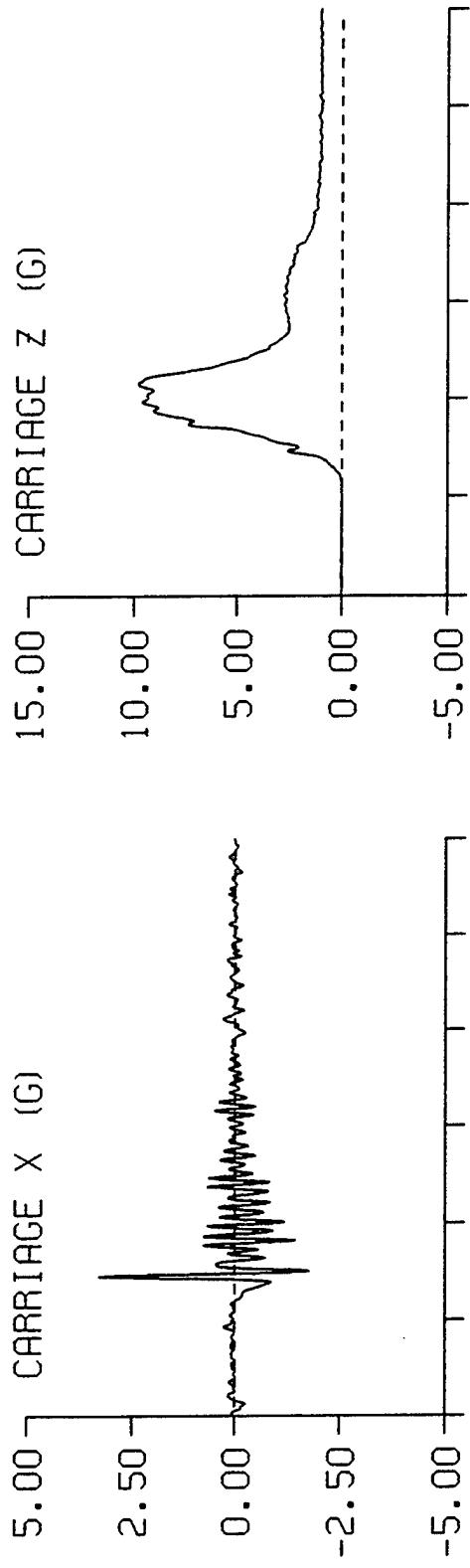
DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
REFERENCE MARK TIME (MS)				-136.	
CARRIAGE ACCELERATION (G)					
X AXIS	0.01	3.30	-1.78	15.	20.
Y AXIS	0.00	1.71	-2.56	364.	48.
Z AXIS	0.03	9.78	0.47	85.	0.
CARRIAGE VELOCITY (FPS)	-26.29	-1.22	-26.93	322.	7.
SEAT ACCELERATION (G)					
X AXIS	0.01	2.71	-1.47	15.	20.
Y AXIS	0.00	1.43	-2.60	66.	53.
Z AXIS	0.03	10.77	-0.06	70.	22.
EXT CHEST ACCELERATION (G)					
X AXIS	-0.01	2.72	-4.17	108.	80.
Y AXIS	0.09	2.20	-1.62	92.	64.
Z AXIS	0.03	18.35	0.07	87.	0.
RESULTANT	0.10	18.39	0.09	87.	0.
HEADREST FORCES (LB)					
UPPER X AXIS	12.16	49.21	-2.87	274.	228.
LOWER X AXIS	5.22	118.99	-2.96	64.	226.
X AXIS SUM	17.39	131.50	-5.34	63.	228.
SHOULDER FORCES (LB)					
X AXIS	-6.03	3.77	-24.54	95.	67.
Y AXIS	-0.30	12.51	-4.23	78.	30.
Z AXIS	-3.05	30.15	-4.30	74.	0.
RESULTANT	7.05	37.84	0.84	72.	263.
LAP FORCES (LB)					
LEFT X AXIS	-27.80	3.08	-28.10	56.	0.
LEFT Y AXIS	8.52	9.26	-6.27	2.	54.
LEFT Z AXIS	-55.90	12.40	-55.00	63.	0.
LEFT RESULTANT	63.01	62.34	2.88	0.	43.
RIGHT X AXIS	-24.87	2.98	-25.06	56.	0.
RIGHT Y AXIS	-13.87	3.34	-14.26	78.	1.
RIGHT Z AXIS	-51.39	11.12	-51.41	59.	0.
RIGHT RESULTANT	58.75	58.77	1.64	0.	37.

JMB STUDY TEST: 3842 TEST DATE: 13-JUL-1997 SUBJ: CG-98 WT: 267.0  
NOM G: 10.0 CELL: B

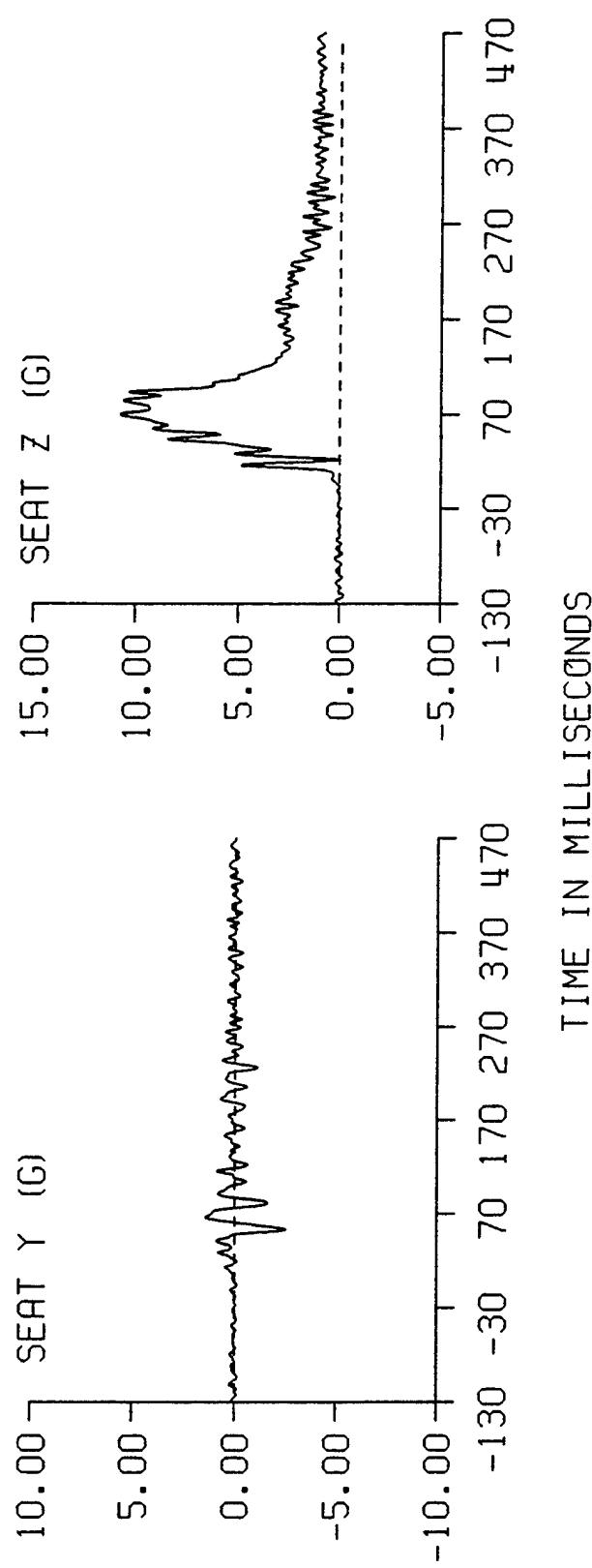
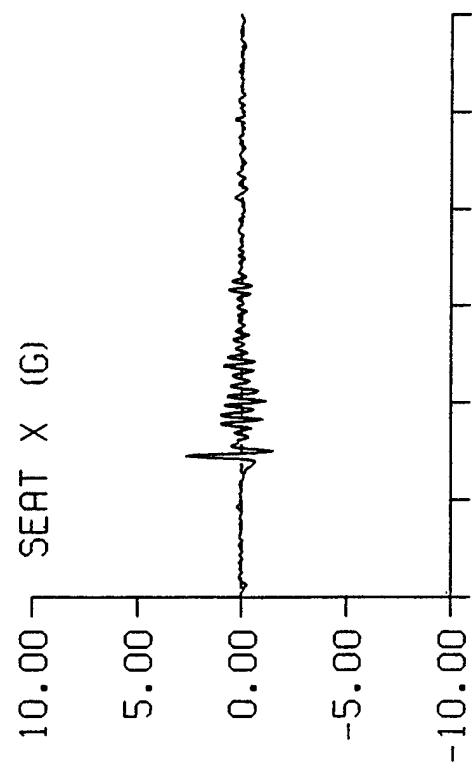
DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
SEAT FORCES (LB)					
LEFT X AXIS	-46.63	-9.32	-351.73	278.	89.
RIGHT X AXIS	-28.52	3.82	-234.35	49.	93.
X AXIS SUM	-75.15	-21.55	-581.33	16.	92.
Y AXIS	2.85	163.73	-71.70	74.	216.
LEFT Z AXIS	29.63	1333.66	28.74	76.	5.
RIGHT Z AXIS	17.57	920.70	13.72	77.	1.
CENTER Z AXIS	-3.41	2457.46	-2.35	77.	5.
Z AXIS SUM	43.79	4711.83	51.10	77.	5.
RESULTANT	87.22	4728.98	94.41	77.	5.
Z SUM MINUS TARE	68.72	4502.82	57.44	77.	9.
RESULTANT MINUS TARE	102.02	4520.76	99.06	77.	5.

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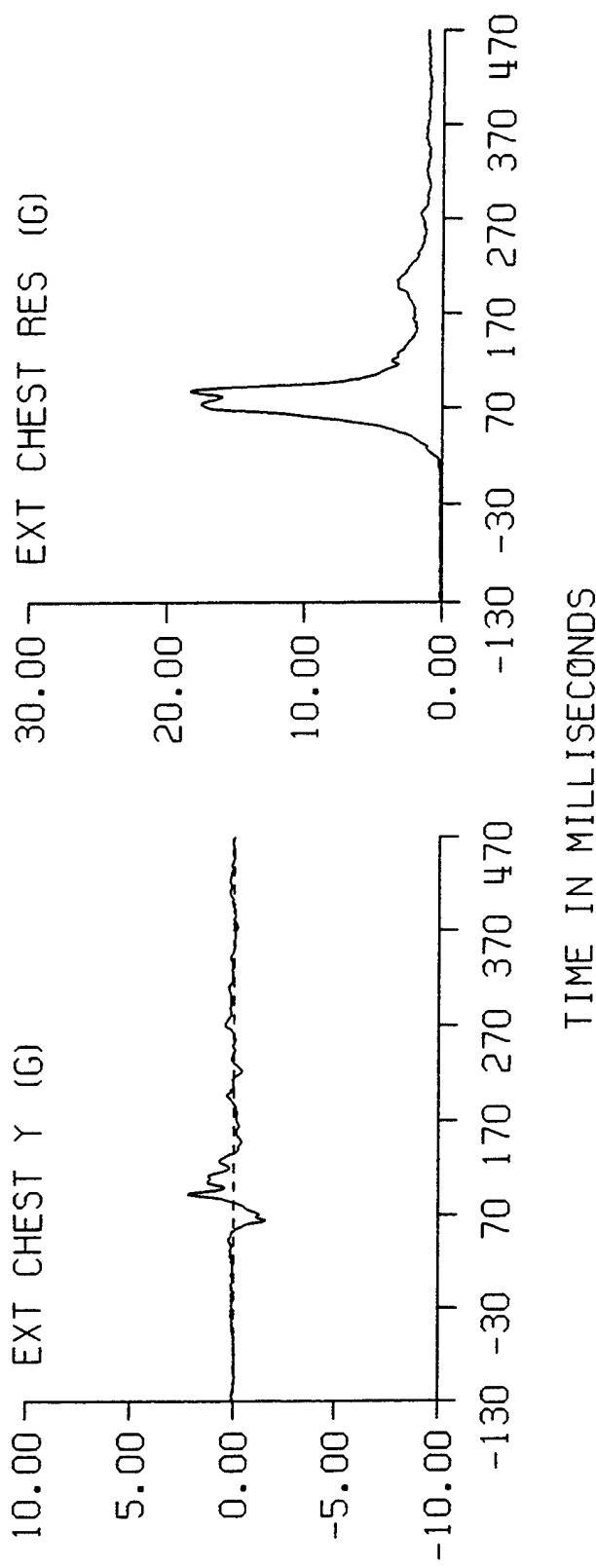
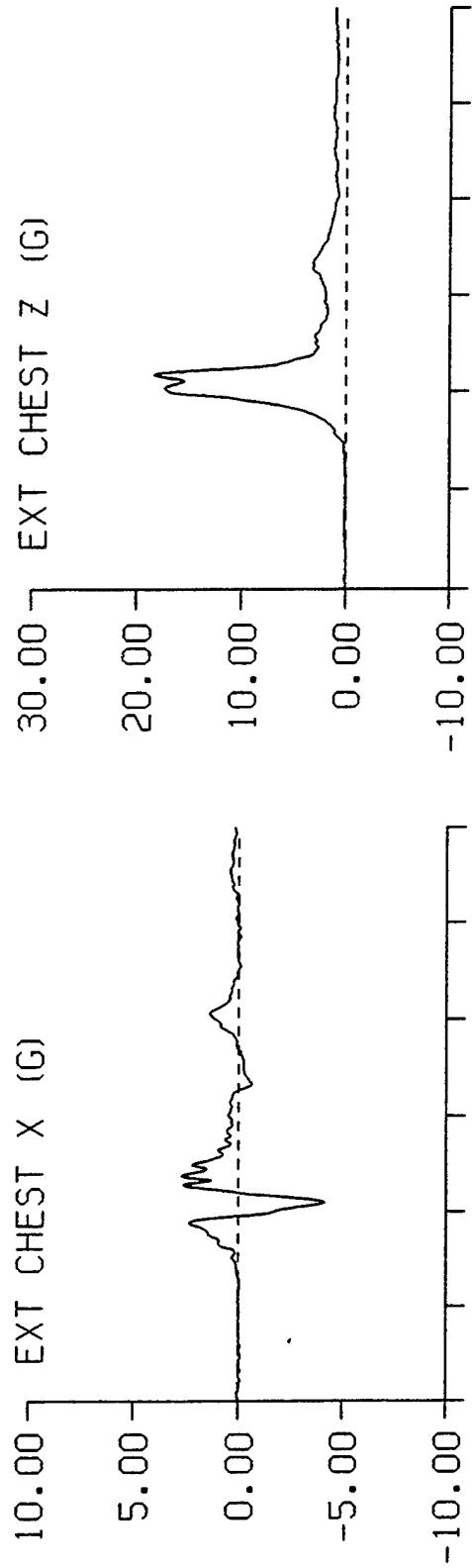
JMB STUDY TEST: 3842 SUBJ: CG-98 CELL: B



JMB STUDY TEST: 3842 SUBJ: CG-98 CELL: B



JMB STUDY TEST: 3842 SUBJ: CG-98 CELL: B



TIME IN MILLISECONDS

JMB STUDY TEST: 3842 SUBJ: CG-98 CELL: B

400.00      UPPER HEADREST X (LB)

200.00

0.00

-200.00

-400.00

400.00      LOWER HEADREST X (LB)

200.00

0.00

-200.00

-400.00

400.00      HEADREST X SUM (LB)

200.00

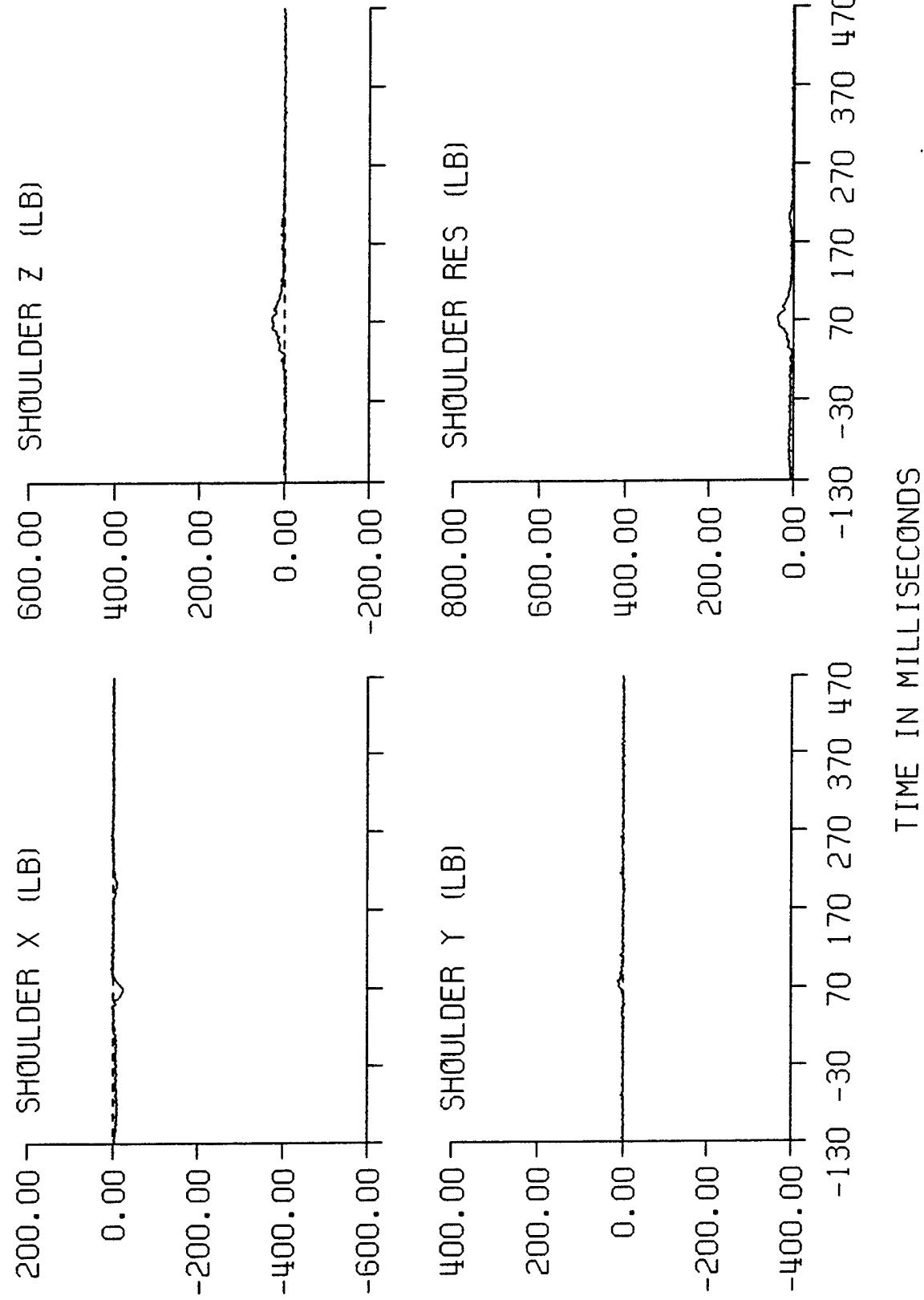
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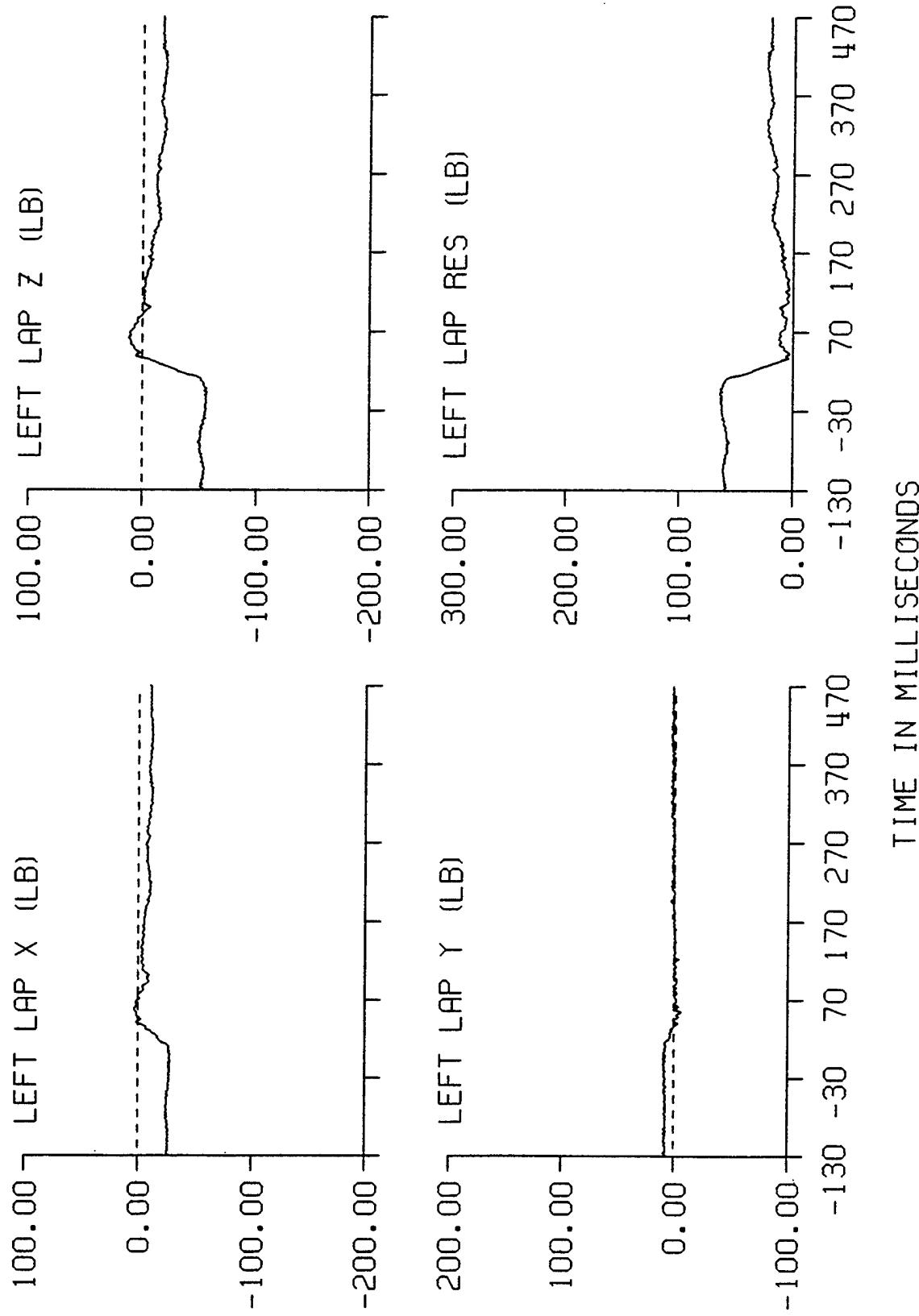
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TIME IN MILLISECONDS

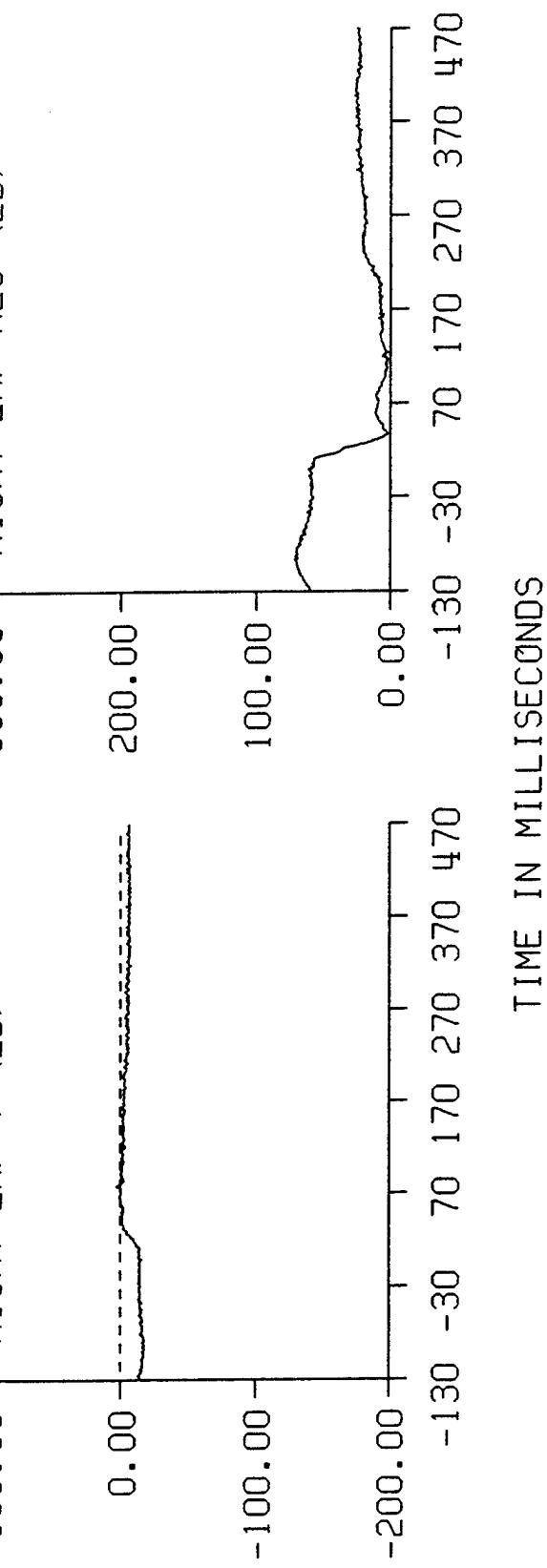
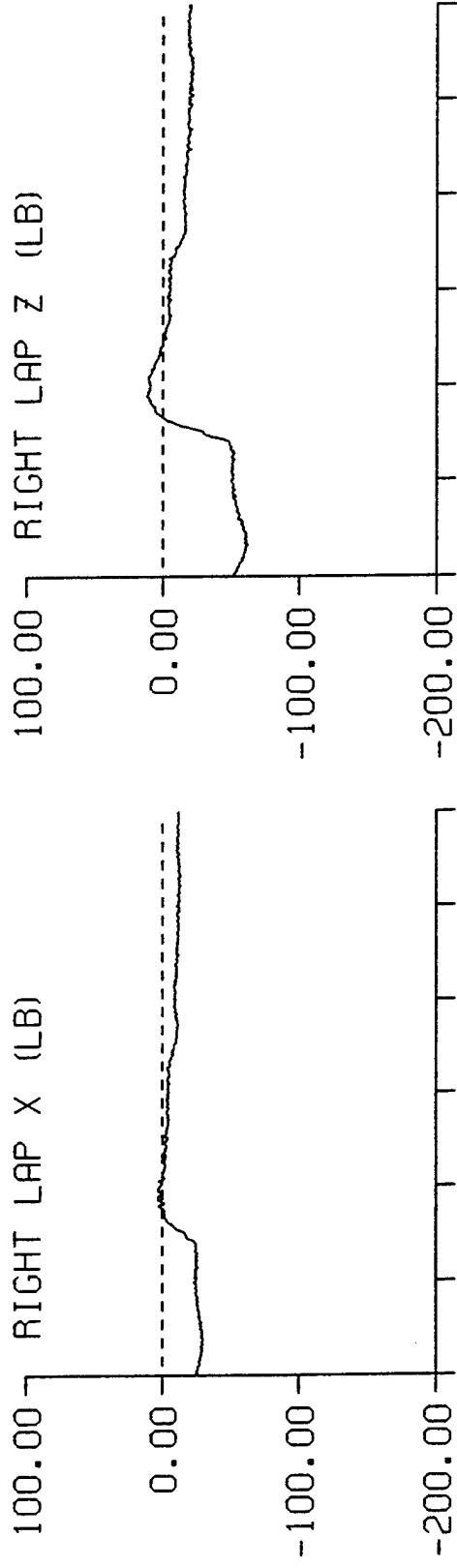
JMB STUDY TEST: 3842 SUBJ: CG-98 CELL: B



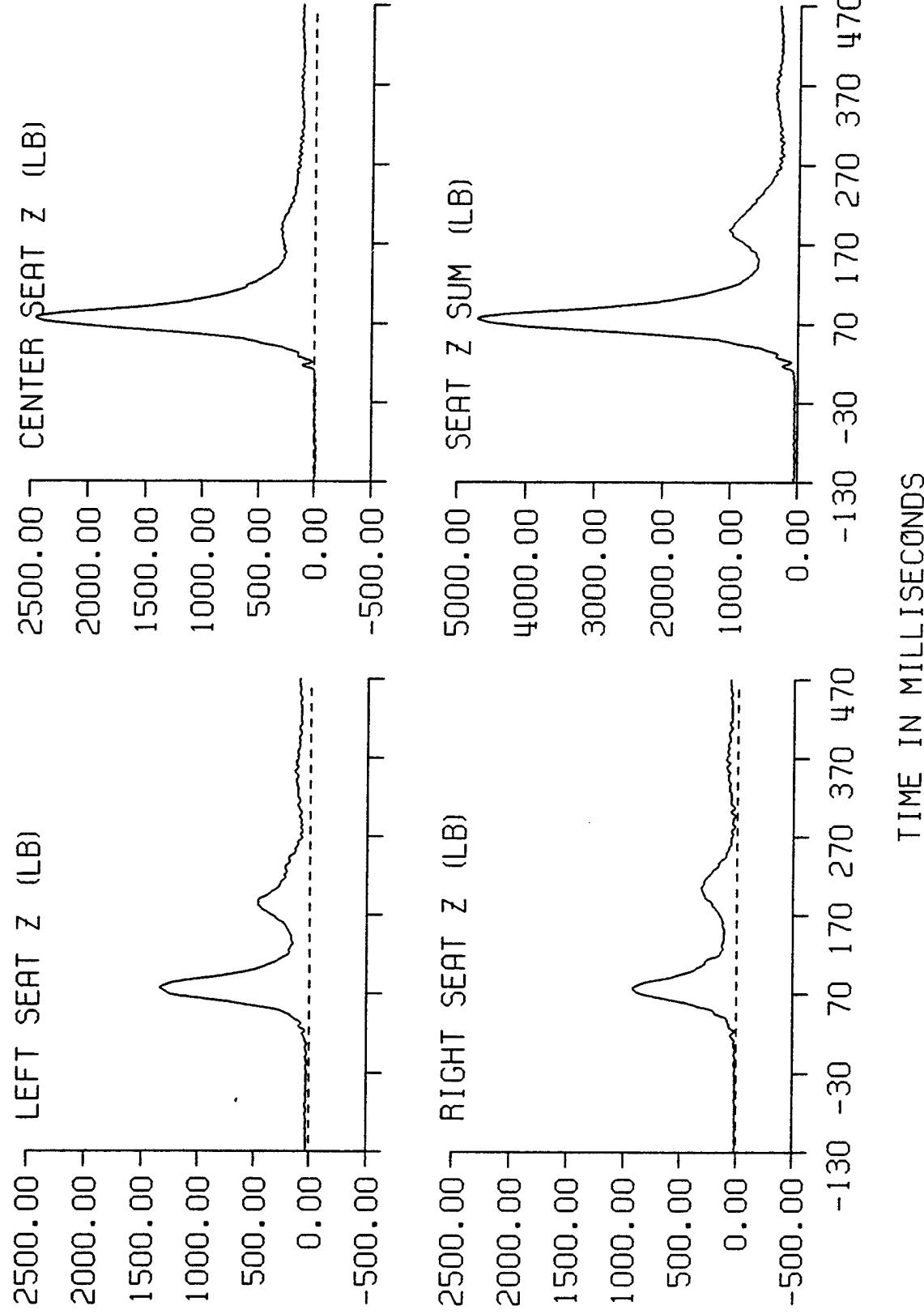
JMB STUDY TEST: 3842 SUBJ: CG-98 CELL: B

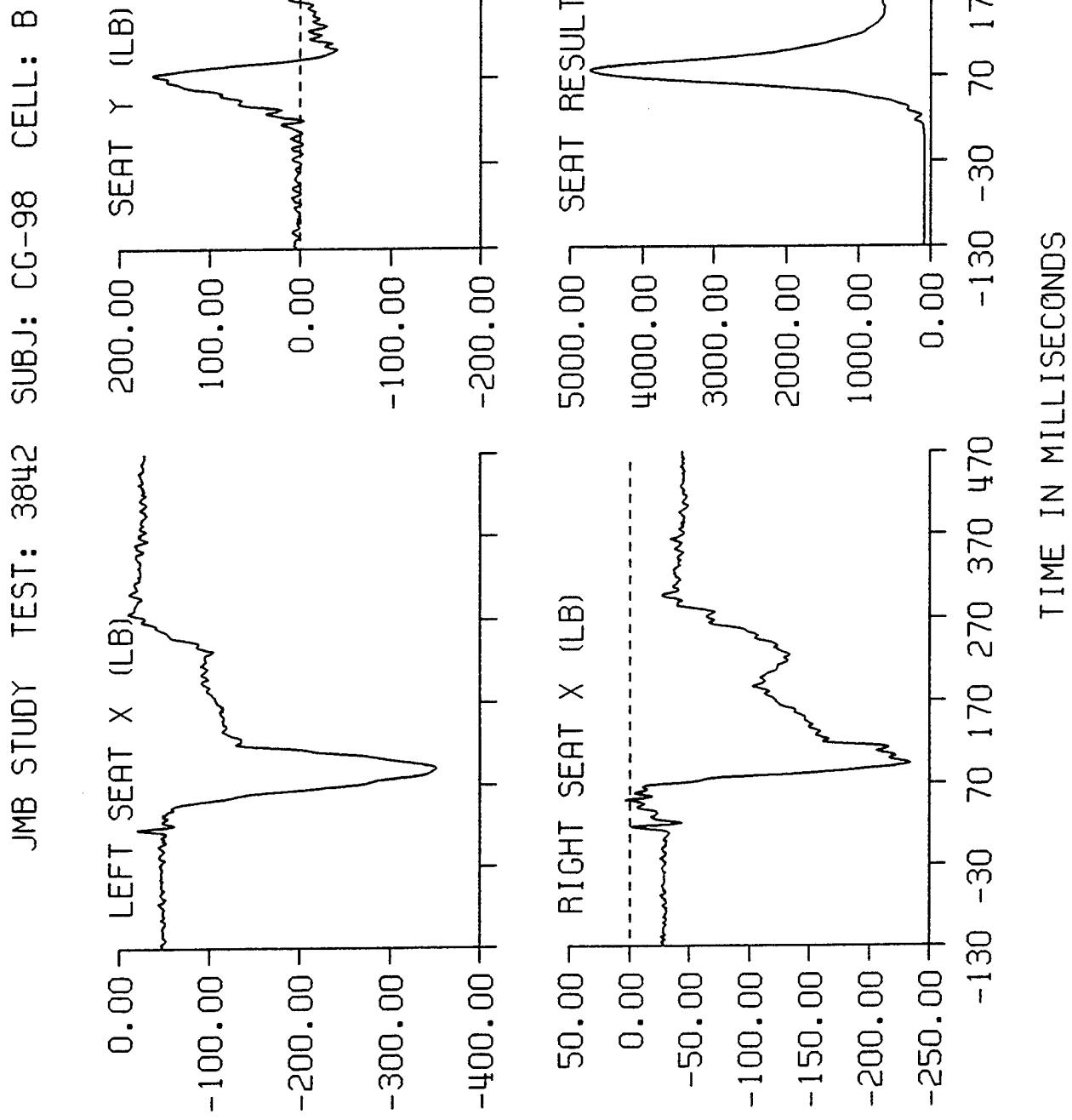


JMB STUDY TEST: 3842 SUBJ: CG-98 CELL: B

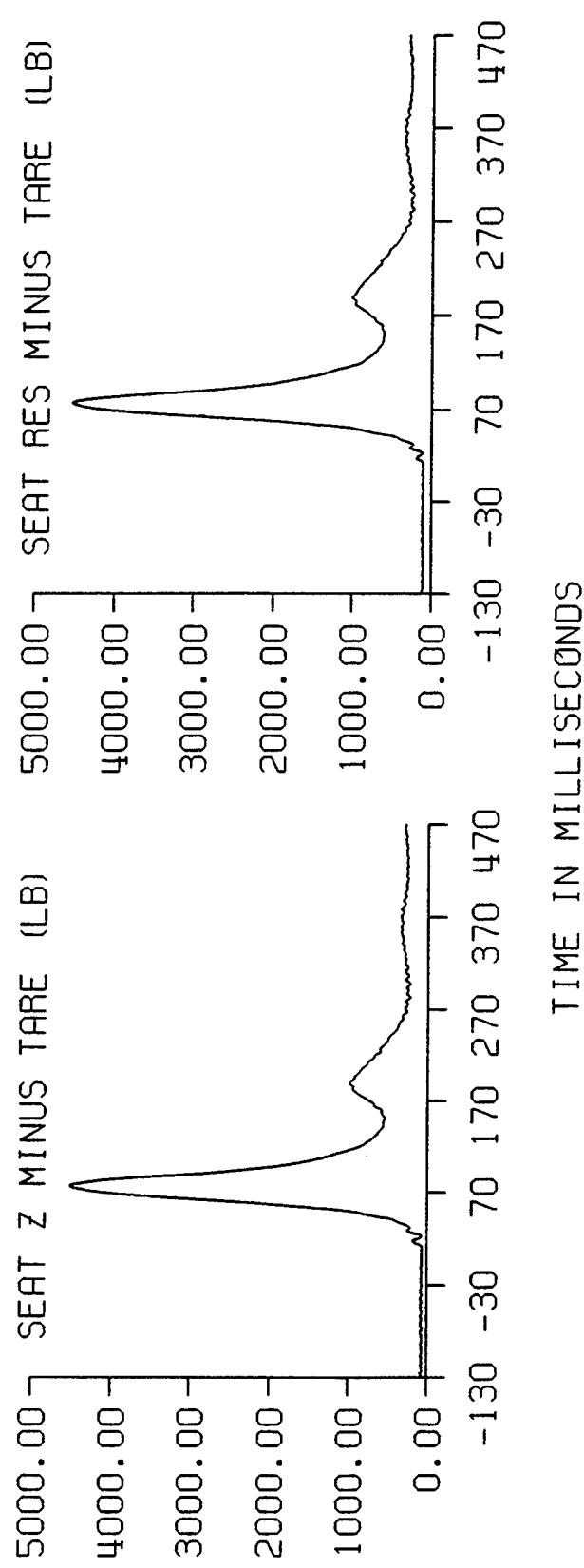
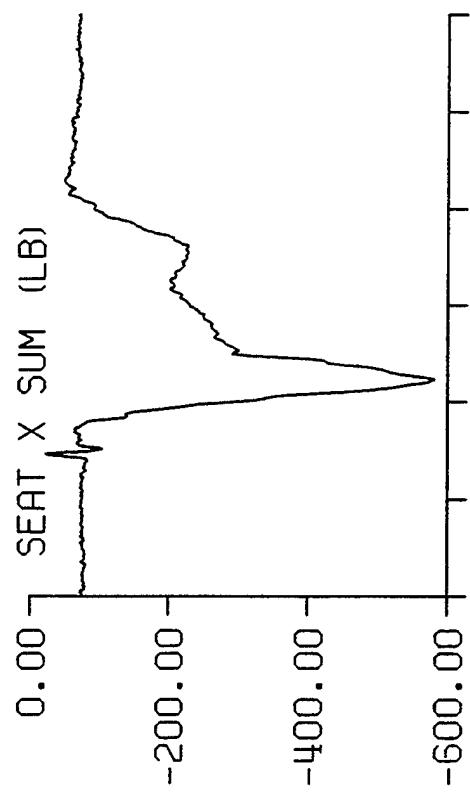


JMB STUDY TEST: 3842 SUBJ: CG-98 CELL: B





JMB STUDY TEST: 3842 SUBJ: CG-98 CELL: B



JMB STUDY TEST: 3844 TEST DATE: 18-JUL-1997 SUBJ: JPAT-L WT: 269.0  
 NOM G: 10.0 CELL: C

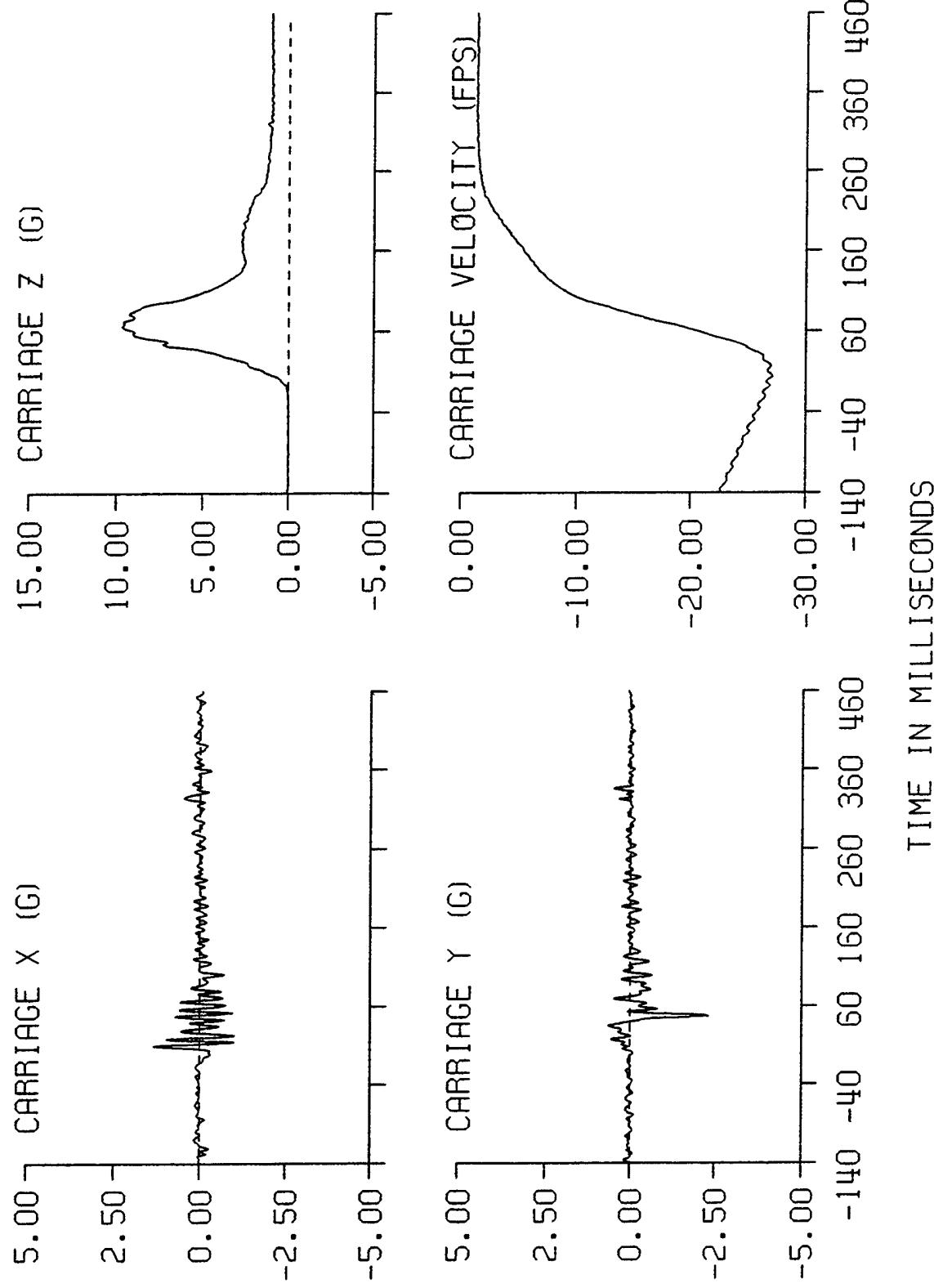
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REFERENCE MARK TIME (MS)				-145.	
CARRIAGE ACCELERATION (G)					
X AXIS	0.01	1.34	-1.04	9.	23.
Y AXIS	0.04	0.64	-2.33	34.	47.
Z AXIS	0.04	9.68	0.45	66.	0.
CARRIAGE VELOCITY (FPS)	-26.49	-1.28	-27.15	324.	3.
SEAT ACCELERATION (G)					
X AXIS	0.00	1.18	-0.95	9.	51.
Y AXIS	0.00	1.98	-2.69	67.	53.
Z AXIS	0.03	10.74	-0.41	73.	323.
EXT CHEST ACCELERATION (G)					
X AXIS	0.02	14.31	-0.73	87.	144.
Y AXIS	0.01	1.28	-2.17	93.	106.
Z AXIS	0.01	14.77	-2.64	86.	155.
RESULTANT	0.06	20.52	0.08	87.	2.
HEADREST FORCES (LB)					
UPPER X AXIS	-3.12	53.38	-15.56	211.	57.
LOWER X AXIS	-1.95	84.70	-5.16	212.	341.
X AXIS SUM	-5.07	137.58	-9.82	211.	15.
SHOULDER FORCES (LB)					
X AXIS	-21.21	-3.49	-170.18	228.	91.
Y AXIS	-6.36	18.32	-7.72	97.	0.
Z AXIS	-7.73	107.76	-9.76	86.	0.
RESULTANT	23.53	199.43	3.87	88.	229.
LAP FORCES (LB)					
LEFT X AXIS	-30.51	1.30	-88.00	48.	203.
LEFT Y AXIS	0.32	10.87	-7.61	195.	52.
LEFT Z AXIS	-56.66	8.54	-140.18	55.	199.
LEFT RESULTANT	64.36	165.82	4.34	203.	39.
RIGHT X AXIS	-26.63	1.68	-74.73	63.	205.
RIGHT Y AXIS	-15.42	1.64	-35.02	65.	206.
RIGHT Z AXIS	-47.92	11.85	-111.77	61.	204.
RIGHT RESULTANT	56.95	138.94	3.84	206.	90.

JMB STUDY TEST: 3844 TEST DATE: 18-JUL-1997 SUBJ: JPAT-L WT: 269.0  
NOM G: 10.0 CELL: C

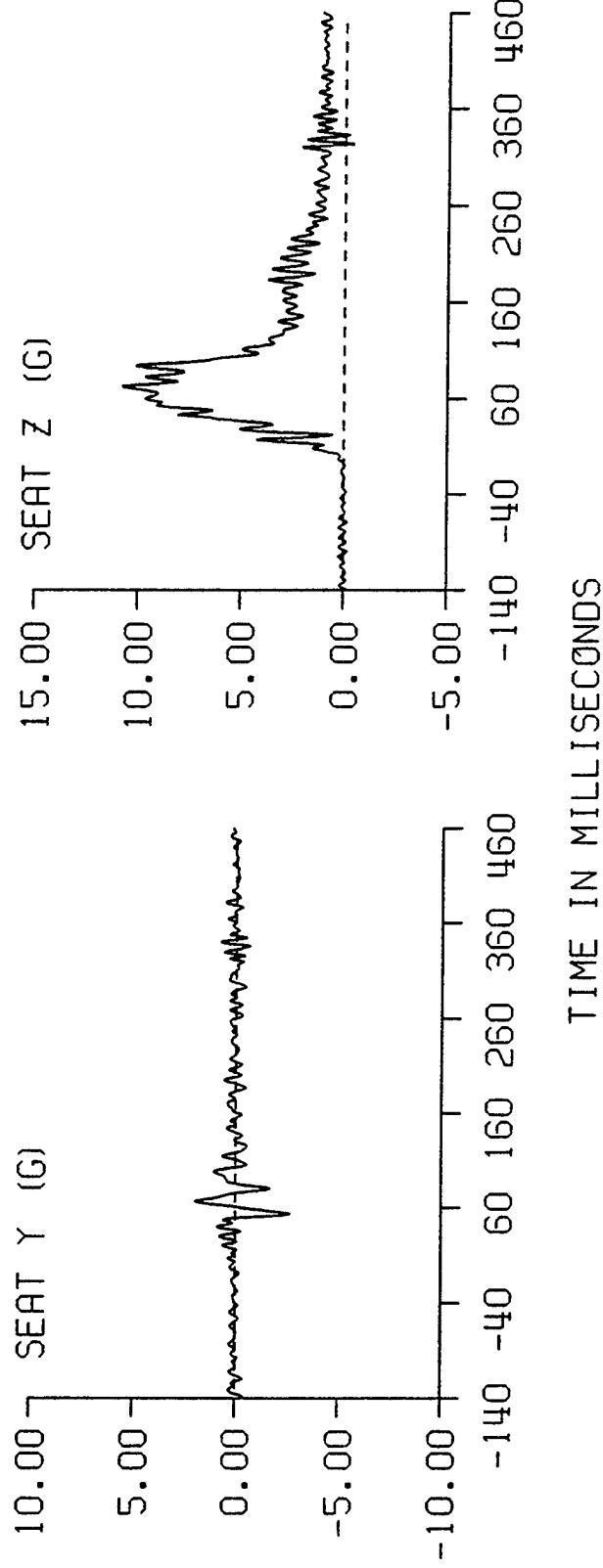
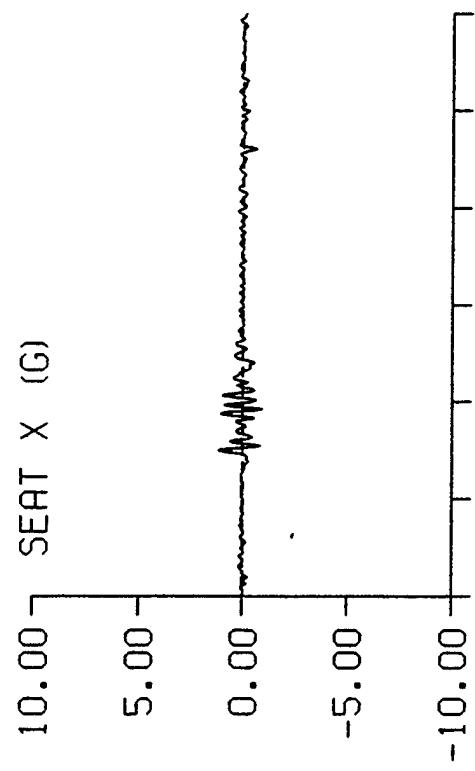
DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
SEAT FORCES (LB)					
LEFT X AXIS	-67.80	77.46	-226.48	199.	112.
RIGHT X AXIS	-15.42	101.05	-146.68	67.	105.
X AXIS SUM	-83.22	76.52	-370.32	191.	106.
Y AXIS	6.18	238.77	-84.62	67.	200.
LEFT Z AXIS	26.12	1836.16	21.67	95.	0.
RIGHT Z AXIS	11.86	1637.18	13.65	95.	3.
CENTER Z AXIS	-34.79	1868.10	-39.63	74.	3.
Z AXIS SUM	3.19	4362.10	0.56	94.	3.
RESULTANT	83.56	4373.49	85.99	94.	10.
Z SUM MINUS TARE	27.82	4187.16	9.93	94.	3.
RESULTANT MINUS TARE	88.02	4199.03	84.06	94.	10.

Page 2 of 2

JMB STUDY TEST: 3844 SUBJ: JPAT-L CELL: C

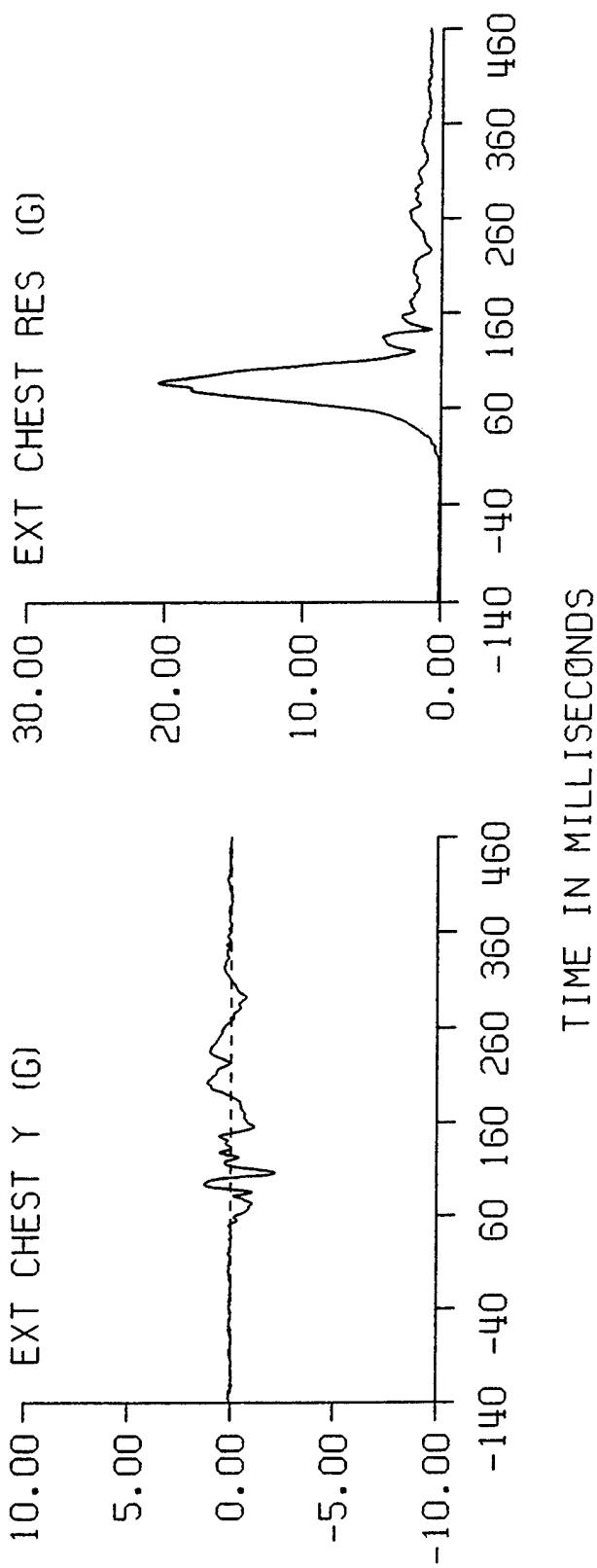
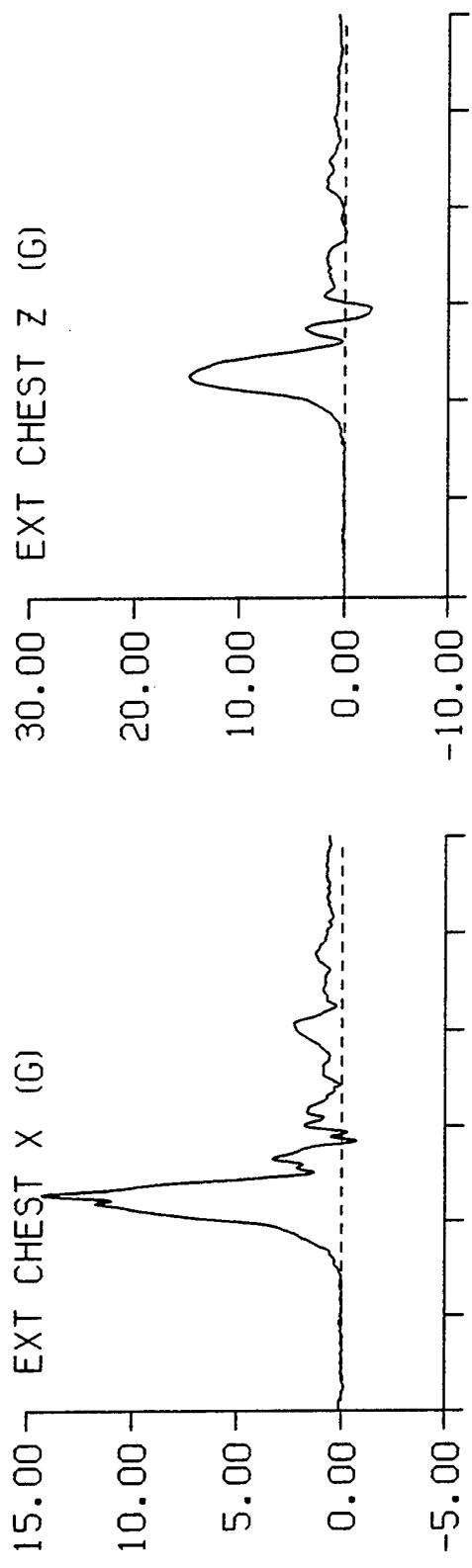


JMB STUDY TEST: 3844 SUBJ: JPAT-L CELL: C

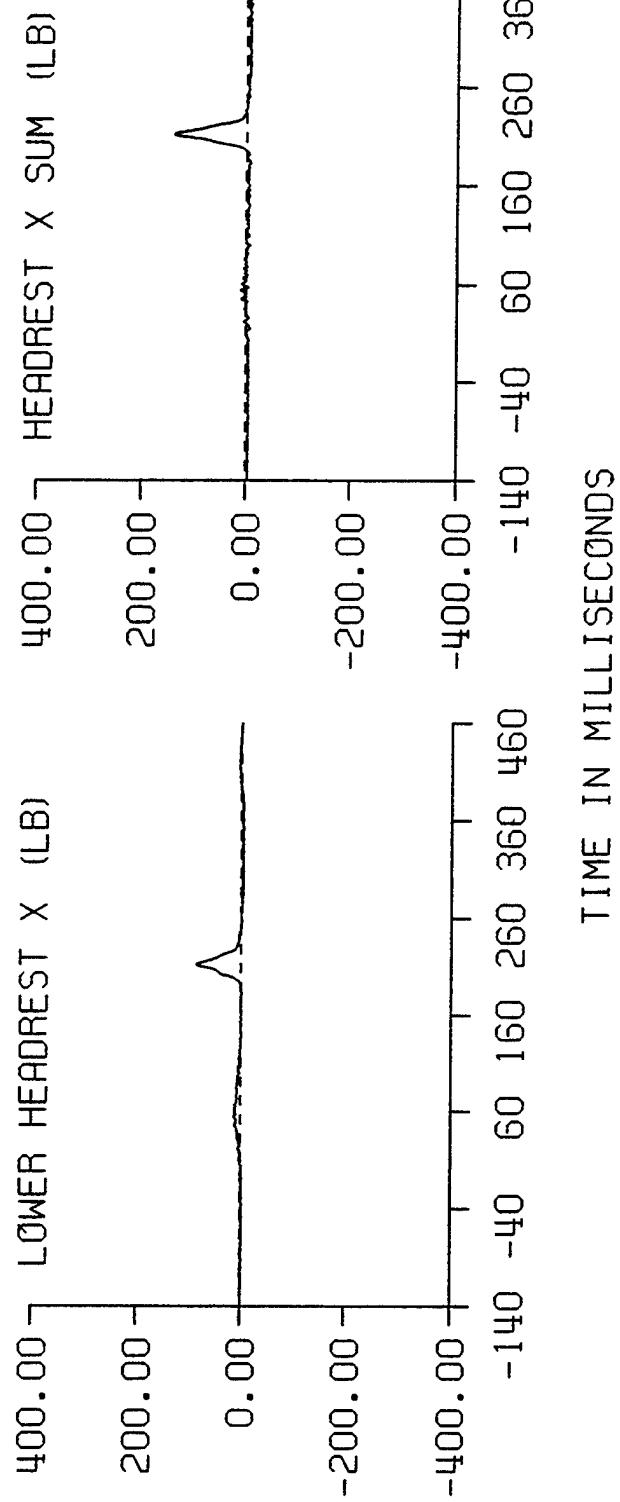
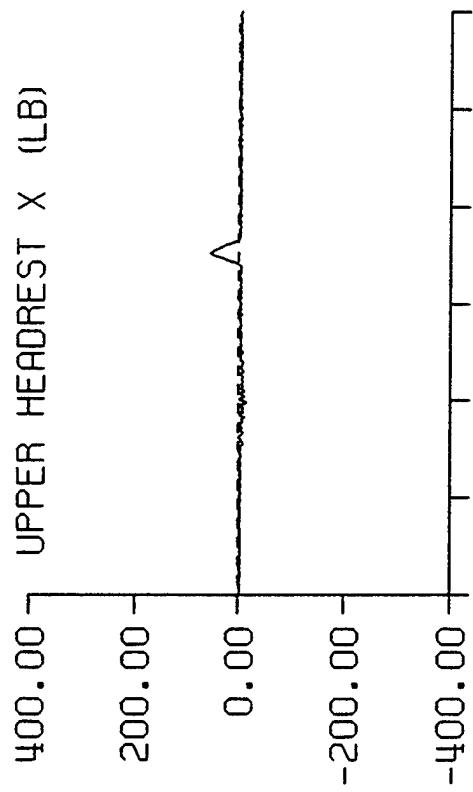


TIME IN MILLISECONDS

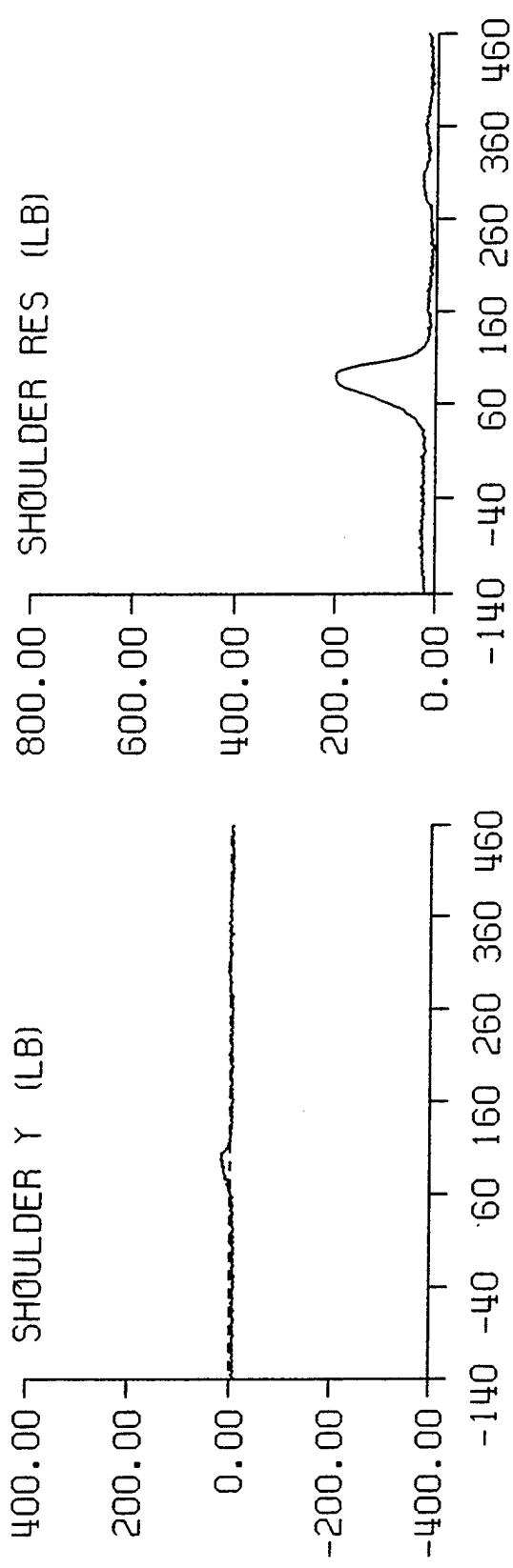
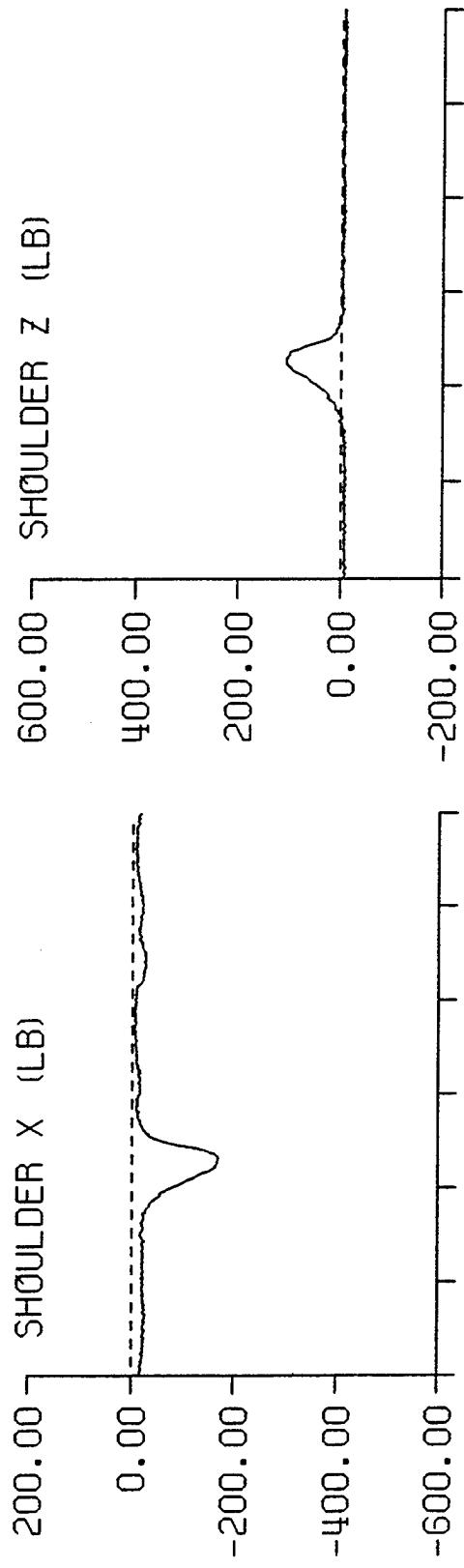
JMB STUDY TEST: 3844 SUBJ: JPAT-L CELL: C



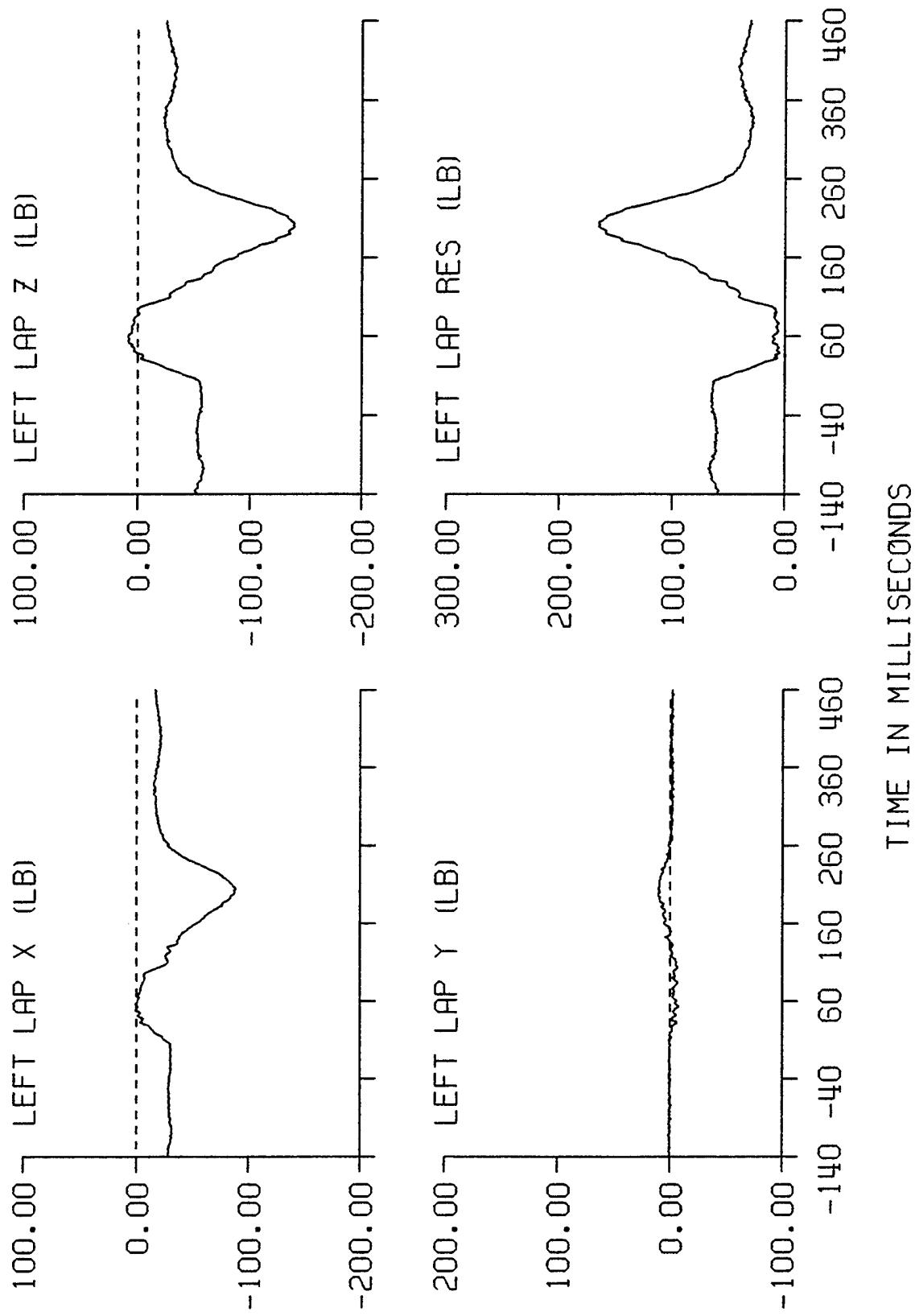
JMB STUDY TEST: 3844 SUBJ: JPAT-L CELL: C



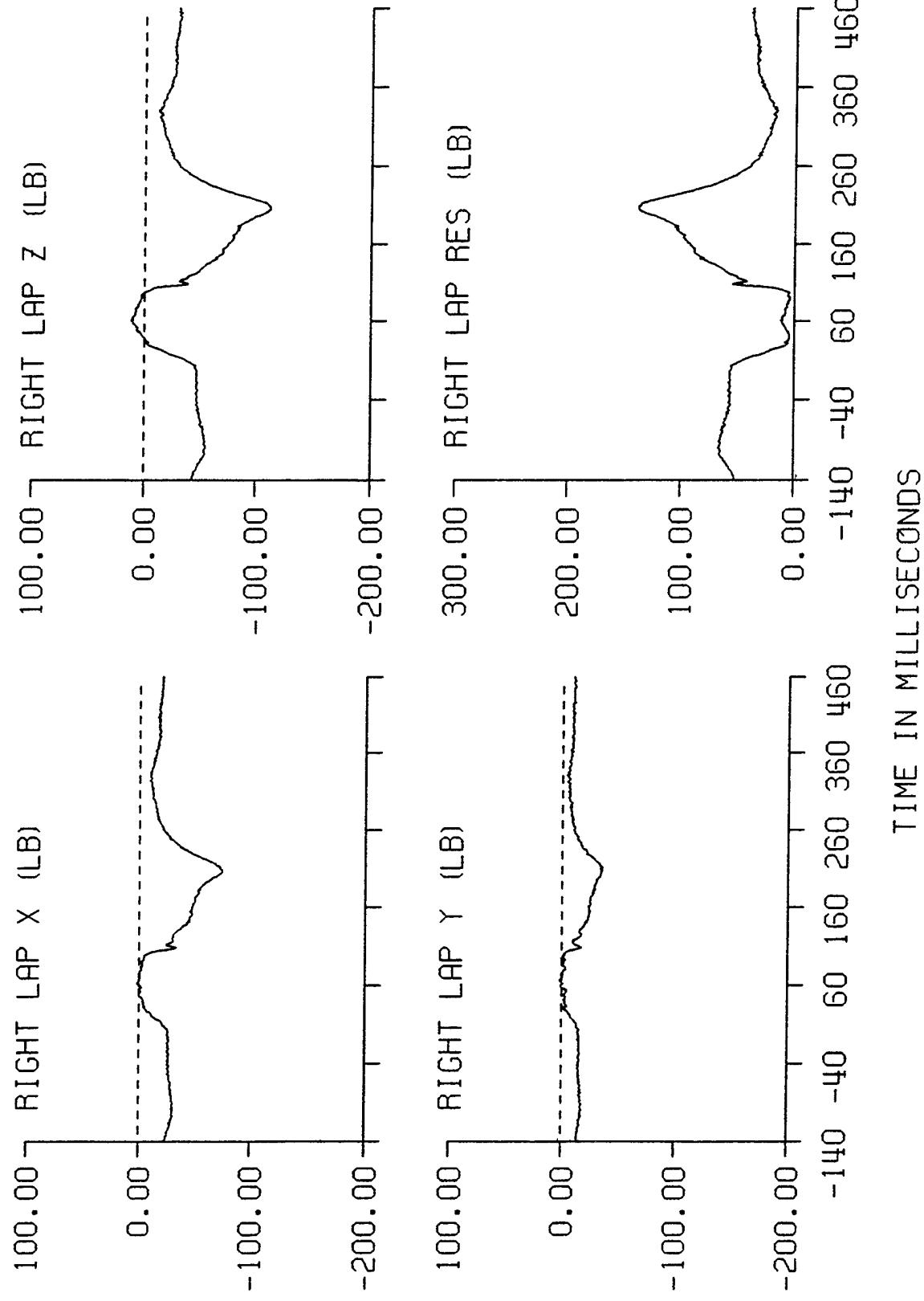
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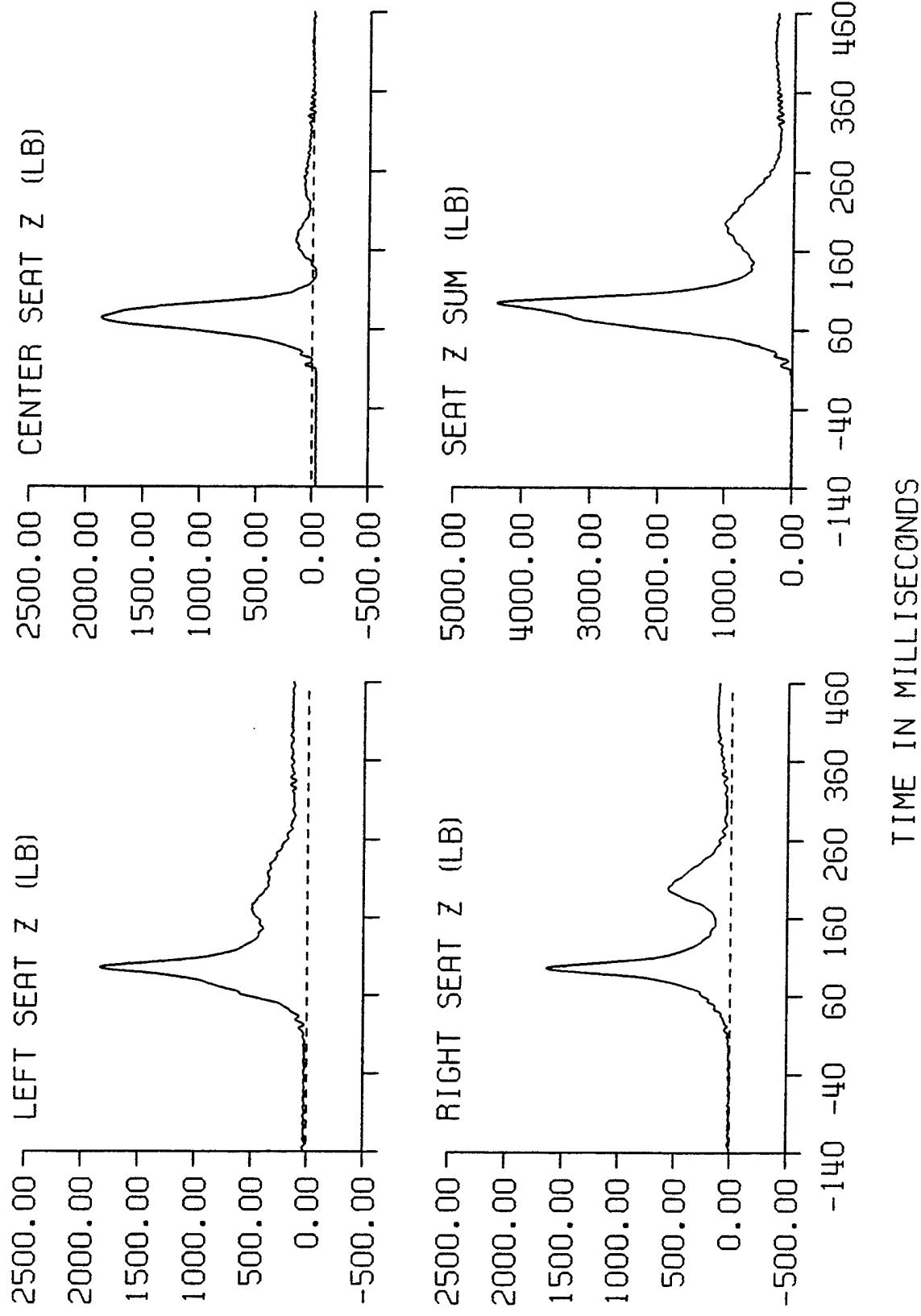
JMB STUDY TEST: 3844 SUBJ: JPAT-L CELL: C



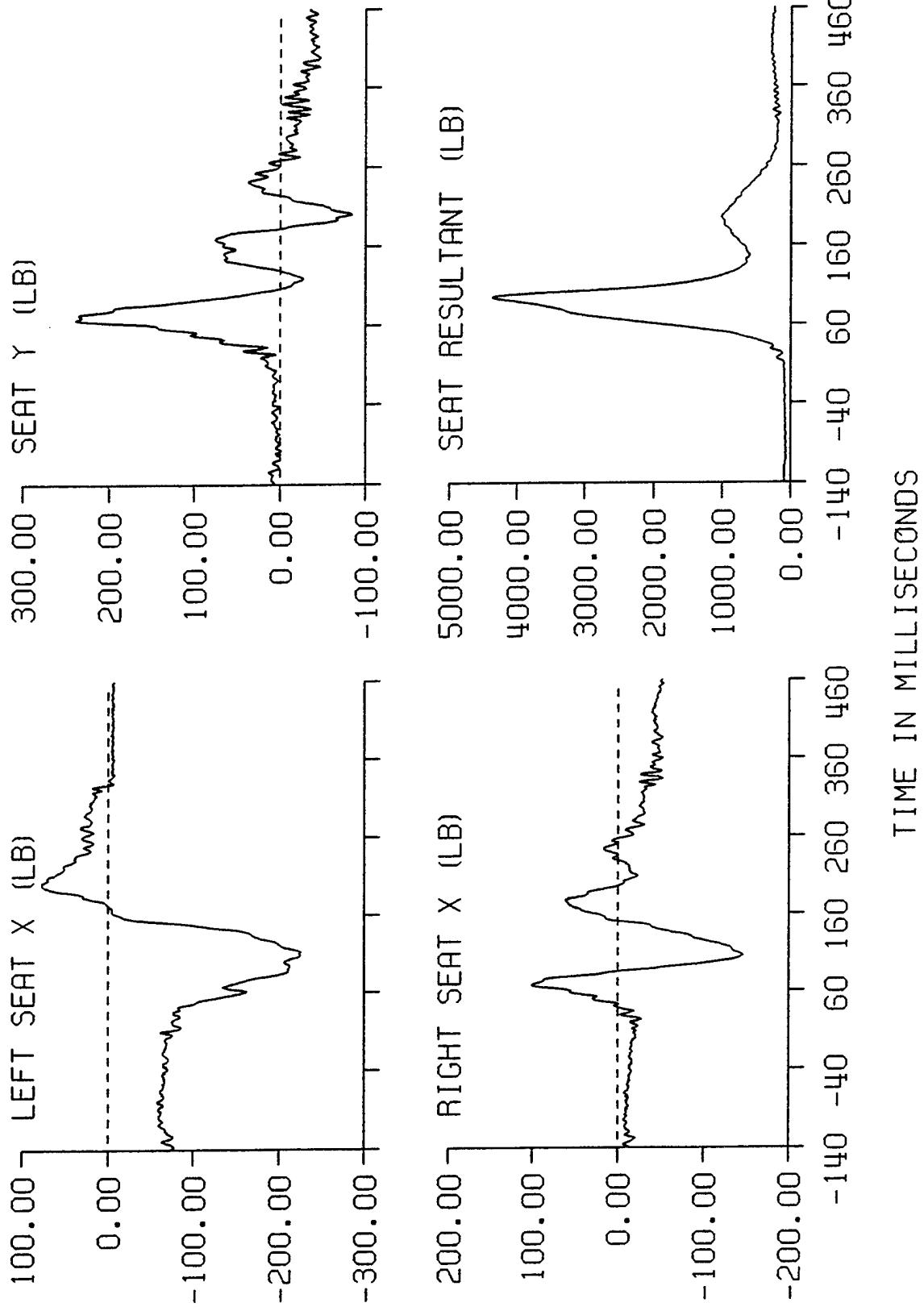
JMB STUDY TEST: 3844 SUBJ: JPAT-L CELL: C



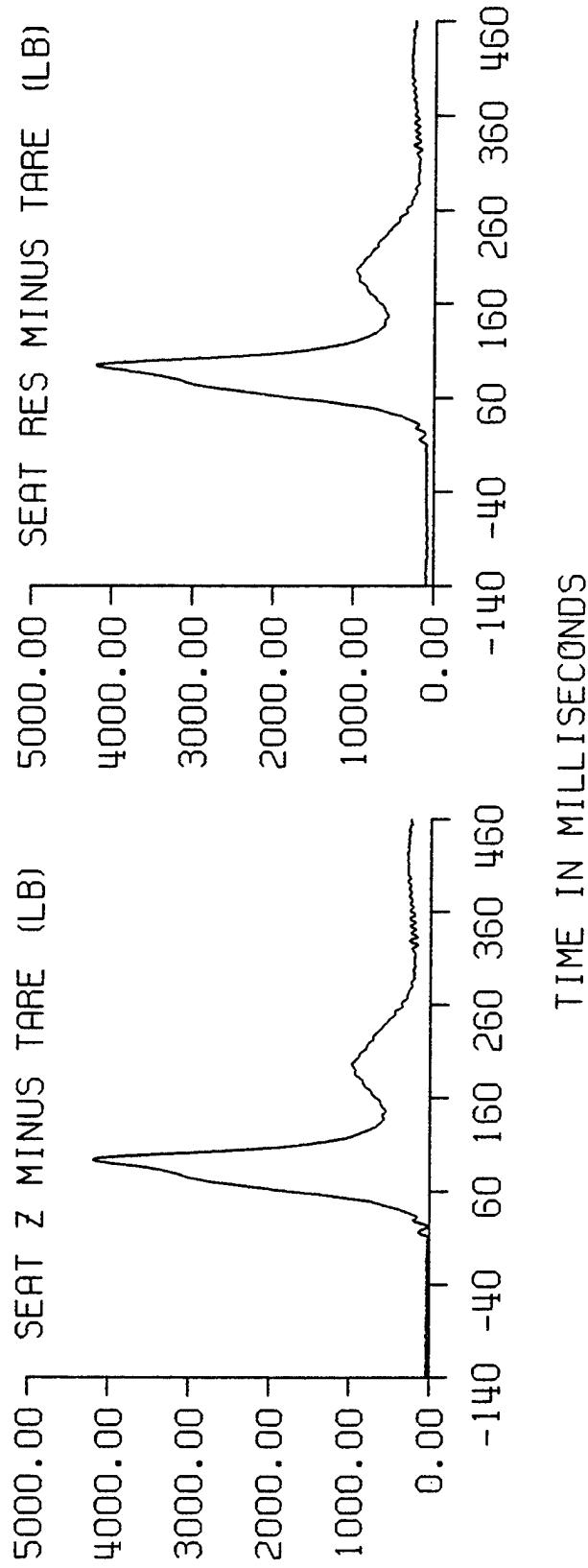
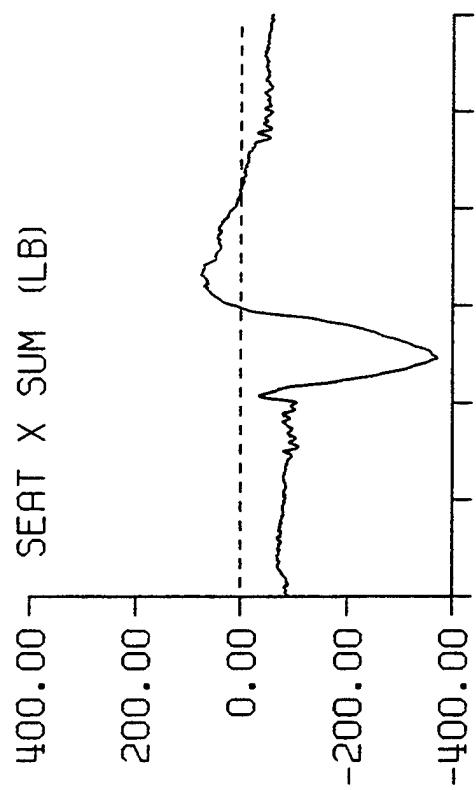
JMB STUDY TEST: 3844 SUBJ: JPAT-L CELL: C



JMB STUDY TEST: 3844 SUBJ: JPAT-L CELL: C



JMB STUDY TEST: 3844 SUBJ: JPAT-L CELL: C



JMB STUDY TEST: 3848 TEST DATE: 19-JUL-1997 SUBJ: JPAT-L WT: 269.0  
NOM G: 10.0 CELL: D

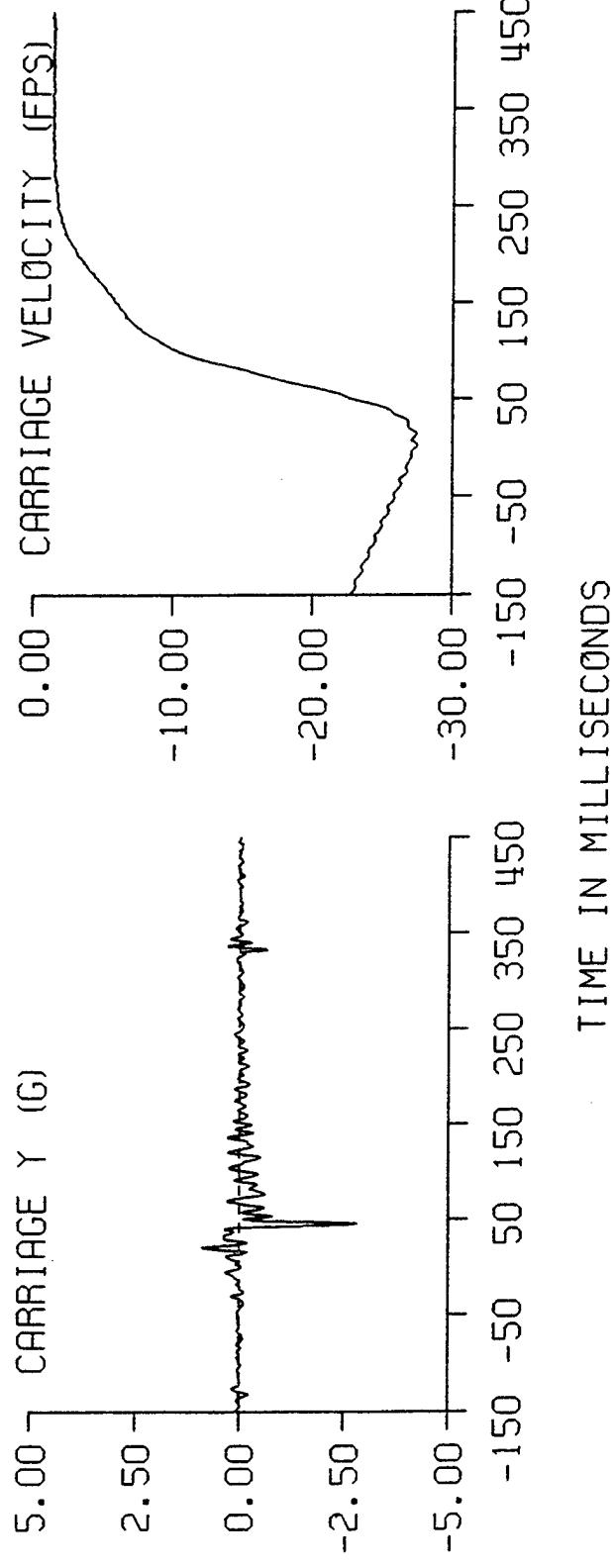
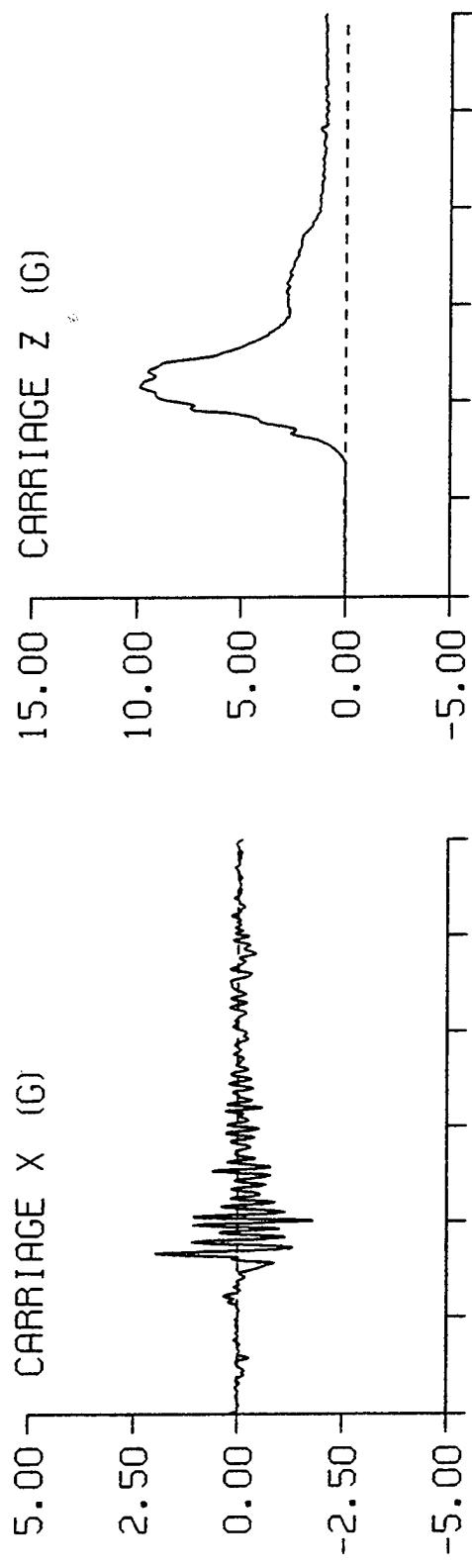
DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
REFERENCE MARK TIME (MS)				-156.	
CARRIAGE ACCELERATION (G)					
X AXIS	0.01	1.97	-1.81	16.	50.
Y AXIS	0.05	0.87	-2.84	20.	45.
Z AXIS	0.05	9.89	0.47	65.	0.
CARRIAGE VELOCITY (FPS)	-26.84	-1.20	-27.47	364.	2.
SEAT ACCELERATION (G)					
X AXIS	0.01	1.53	-1.28	16.	51.
Y AXIS	0.02	1.90	-2.62	63.	50.
Z AXIS	0.06	11.27	-0.57	67.	334.
EXT CHEST ACCELERATION (G)					
X AXIS	0.03	14.01	-1.20	82.	155.
Y AXIS	-0.01	3.70	-3.18	93.	110.
Z AXIS	0.05	16.16	-2.86	80.	259.
RESULTANT	0.09	21.46	0.10	82.	0.
HEADREST FORCES (LB)					
UPPER X AXIS	0.40	25.53	-11.67	228.	56.
LOWER X AXIS	-5.86	64.90	-6.20	228.	0.
X AXIS SUM	-5.45	90.42	-9.93	228.	352.
SHOULDER FORCES (LB)					
X AXIS	-11.69	-0.44	-159.27	253.	88.
Y AXIS	-6.53	17.15	-10.75	91.	16.
Z AXIS	-7.20	108.05	-9.46	84.	254.
RESULTANT	15.30	191.77	4.10	84.	214.
LAP FORCES (LB)					
LEFT X AXIS	-27.94	4.09	-63.95	56.	155.
LEFT Y AXIS	8.27	18.62	-5.78	163.	50.
LEFT Z AXIS	-56.82	13.93	-109.15	57.	155.
LEFT RESULTANT	63.86	127.56	2.78	155.	40.
RIGHT X AXIS	-24.00	1.69	-62.10	45.	147.
RIGHT Y AXIS	-12.71	4.18	-34.67	67.	144.
RIGHT Z AXIS	-46.93	11.19	-105.16	65.	150.
RIGHT RESULTANT	54.22	125.82	2.25	150.	37.

JMB STUDY TEST: 3848 TEST DATE: 19-JUL-1997 SUBJ: JPAT-L WT: 269.0  
NOM G: 10.0 CELL: D

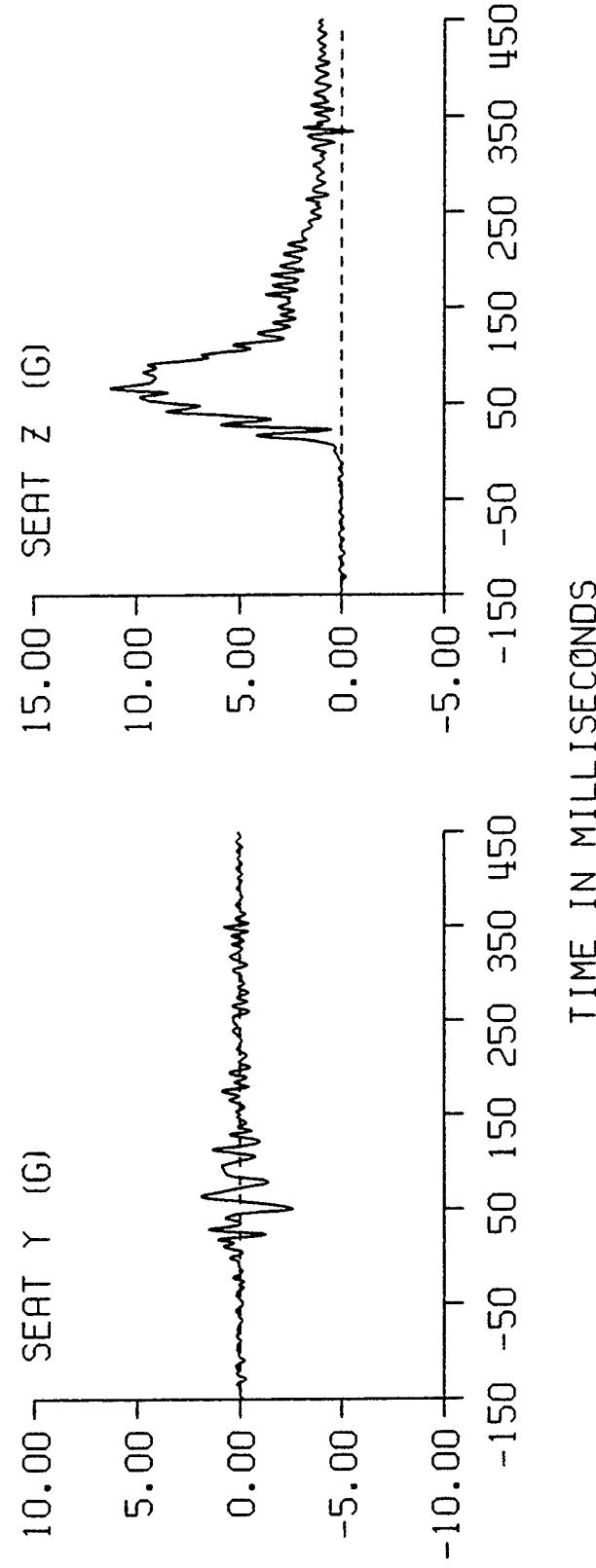
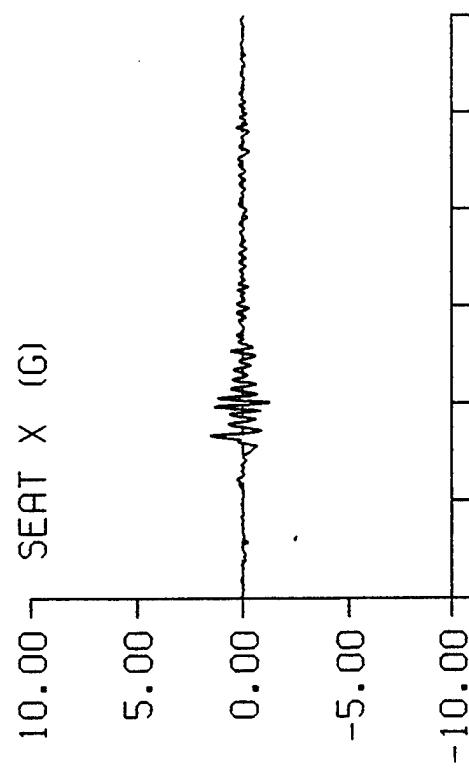
DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
SEAT FORCES (LB)					
LEFT X AXIS	-64.84	23.63	-224.97	196.	86.
RIGHT X AXIS	-31.87	38.21	-190.39	173.	98.
X AXIS SUM	-96.71	51.39	-403.09	194.	97.
Y AXIS	12.49	210.26	-36.17	67.	146.
LEFT Z AXIS	29.45	1562.82	25.61	102.	0.
RIGHT Z AXIS	30.59	1883.11	33.74	96.	6.
CENTER Z AXIS	-24.92	1873.73	-30.93	74.	155.
Z AXIS SUM	35.13	4115.24	38.22	93.	0.
RESULTANT	103.79	4132.18	114.83	93.	0.
Z SUM MINUS TARE	59.66	3948.78	44.59	94.	8.
RESULTANT MINUS TARE	114.42	3967.37	118.74	94.	10.

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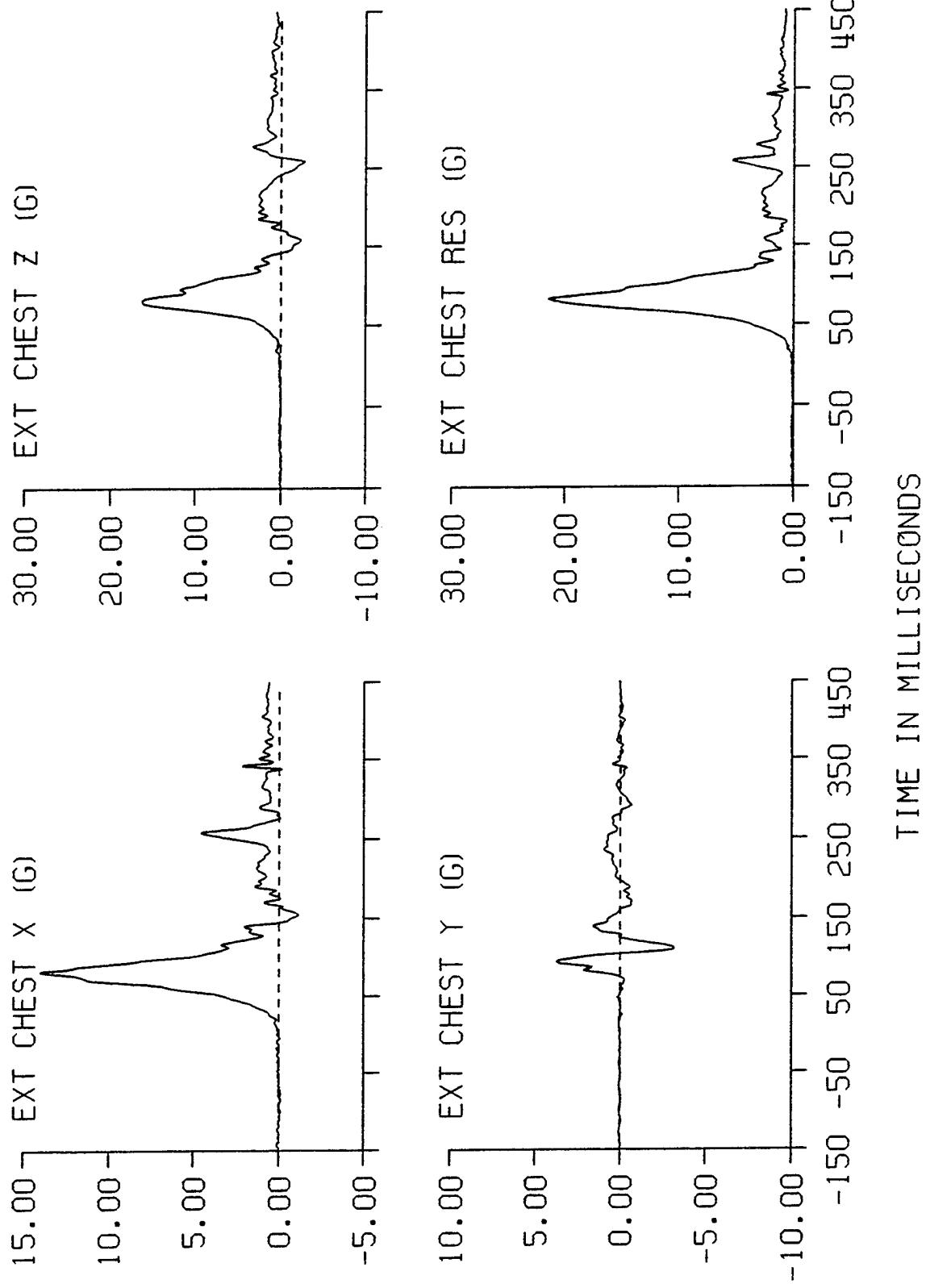
JMB STUDY TEST: 3848 SUBJ: JPAT-L CELL: D



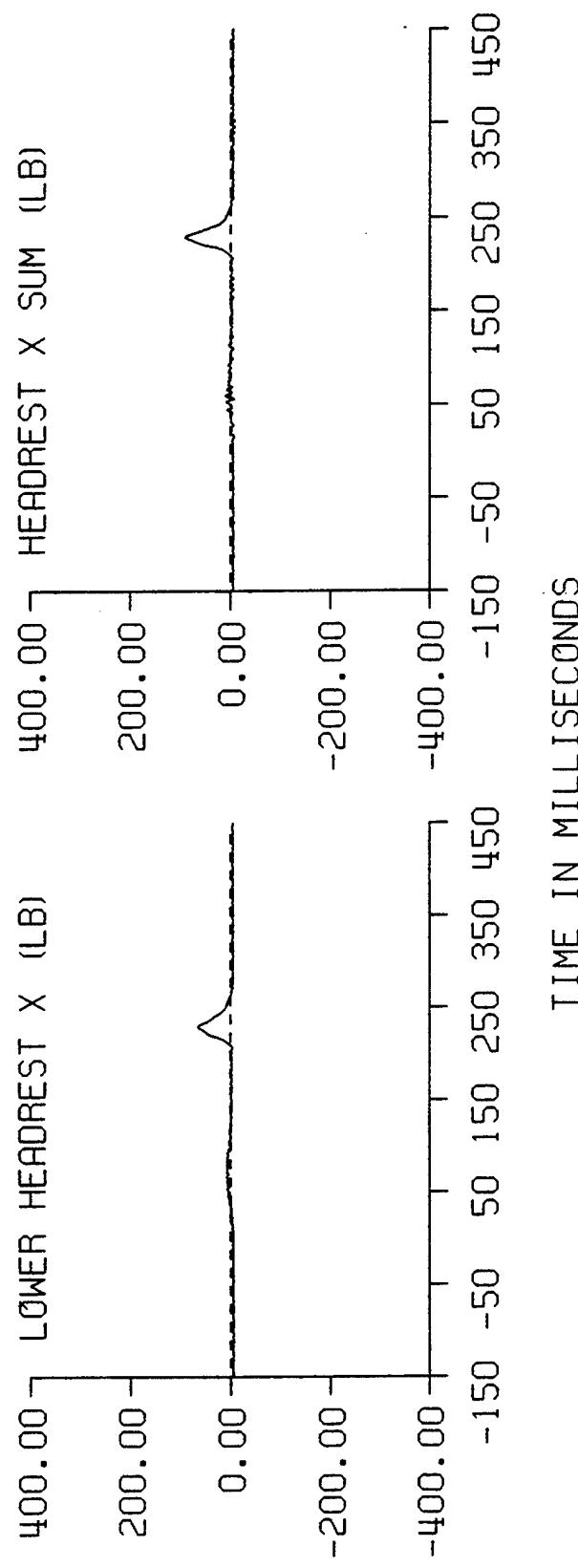
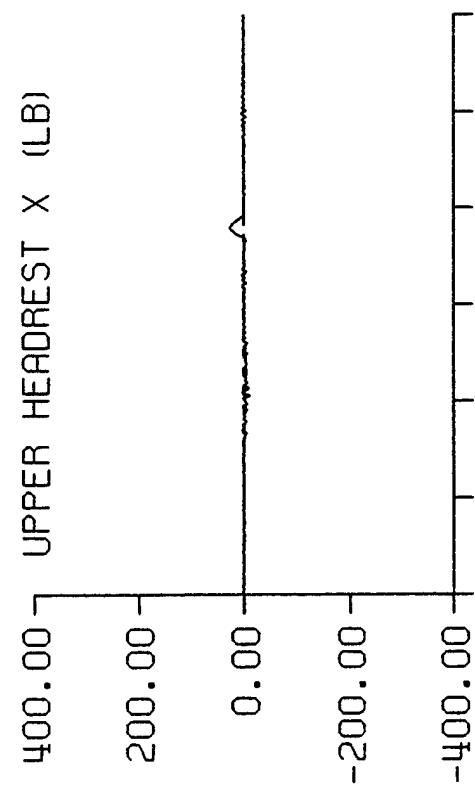
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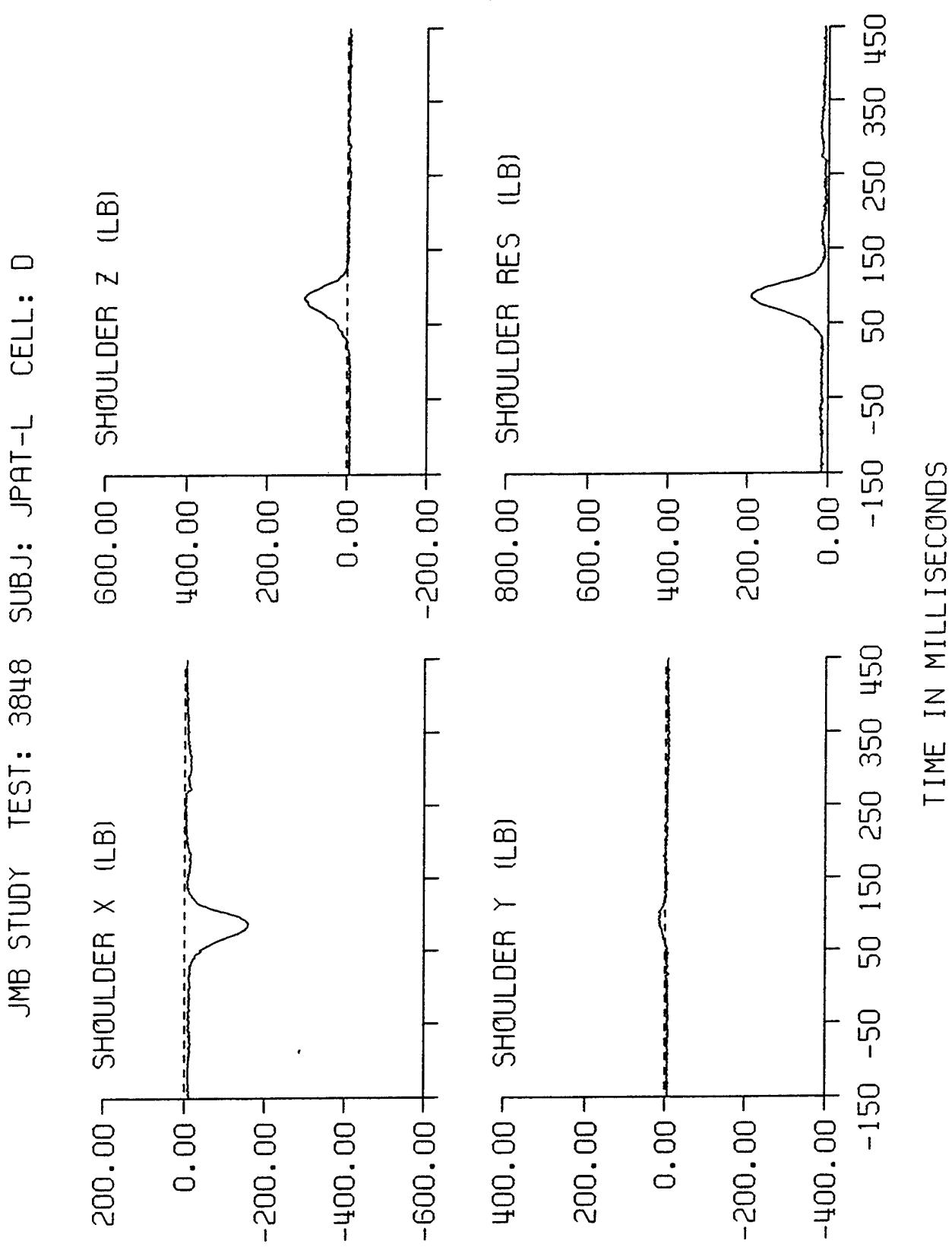


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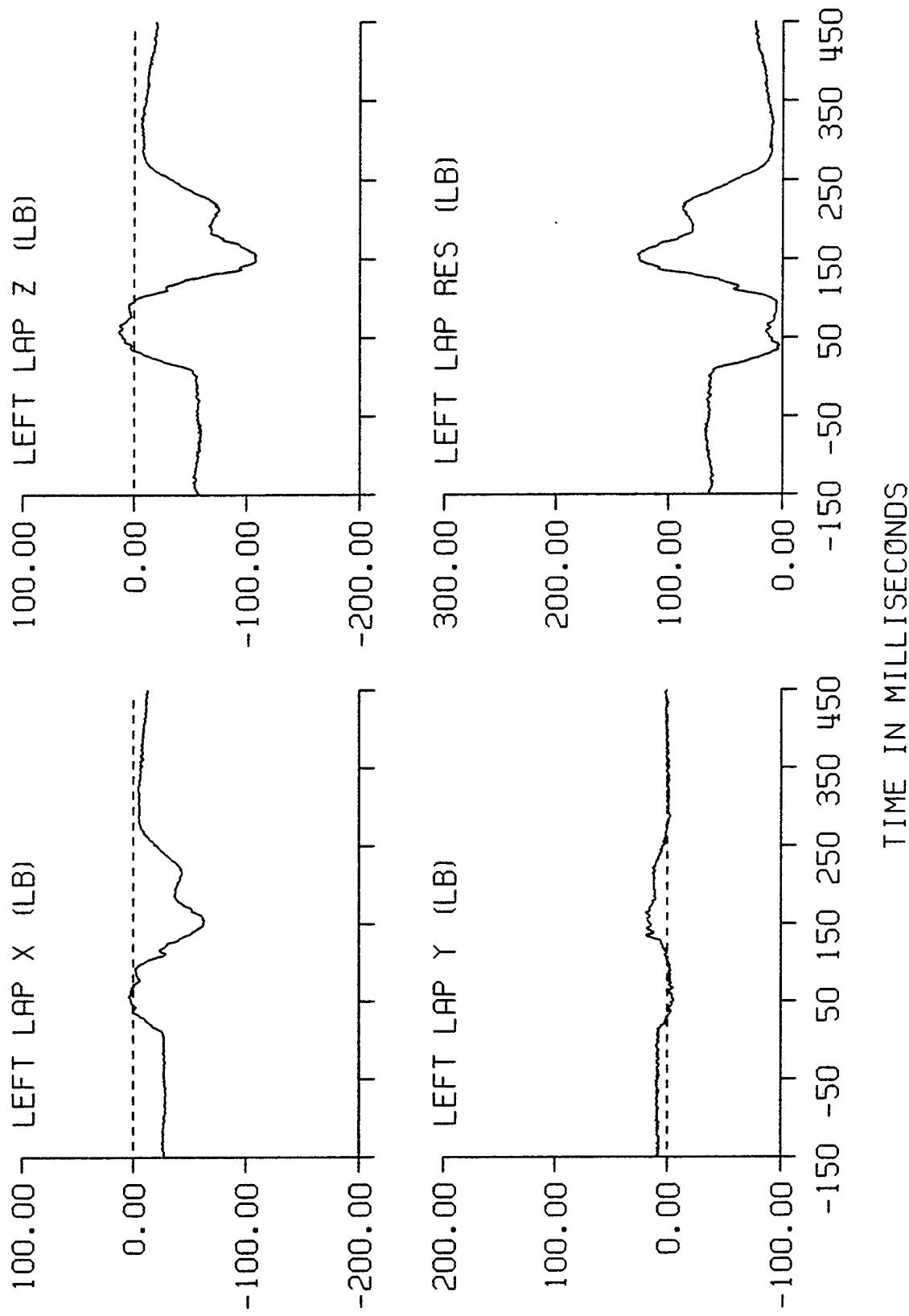


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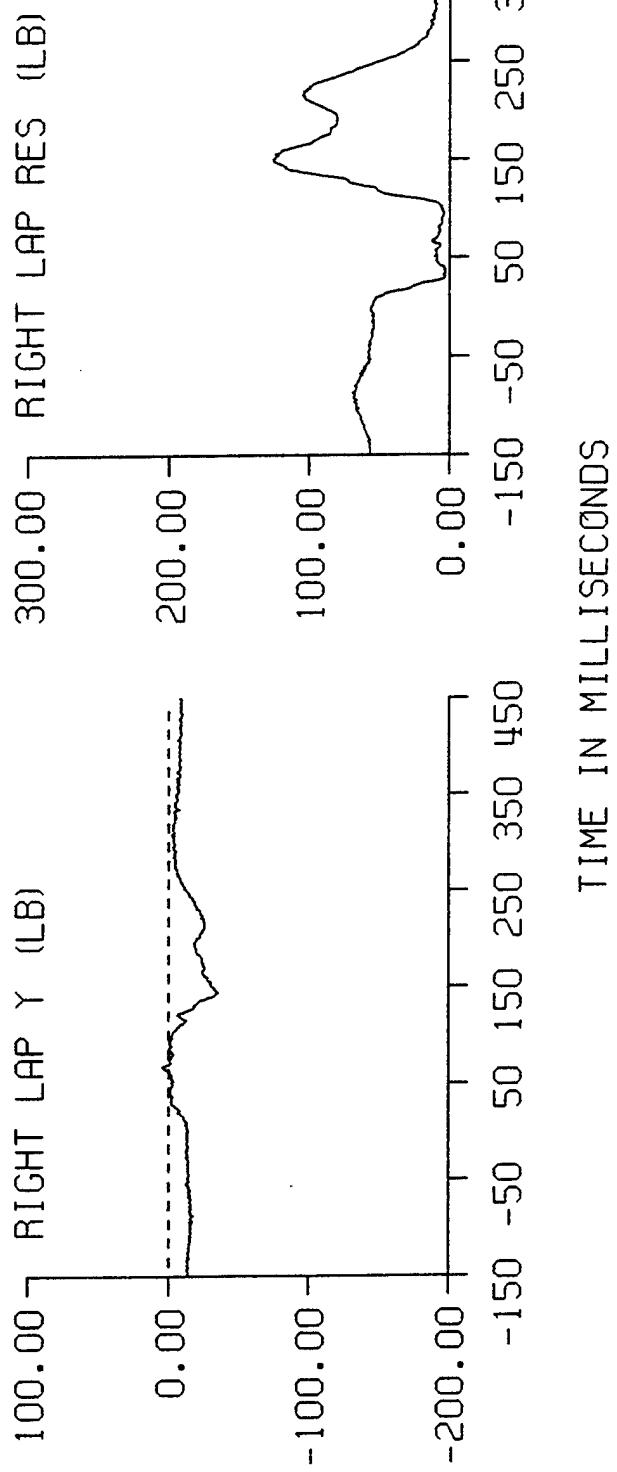
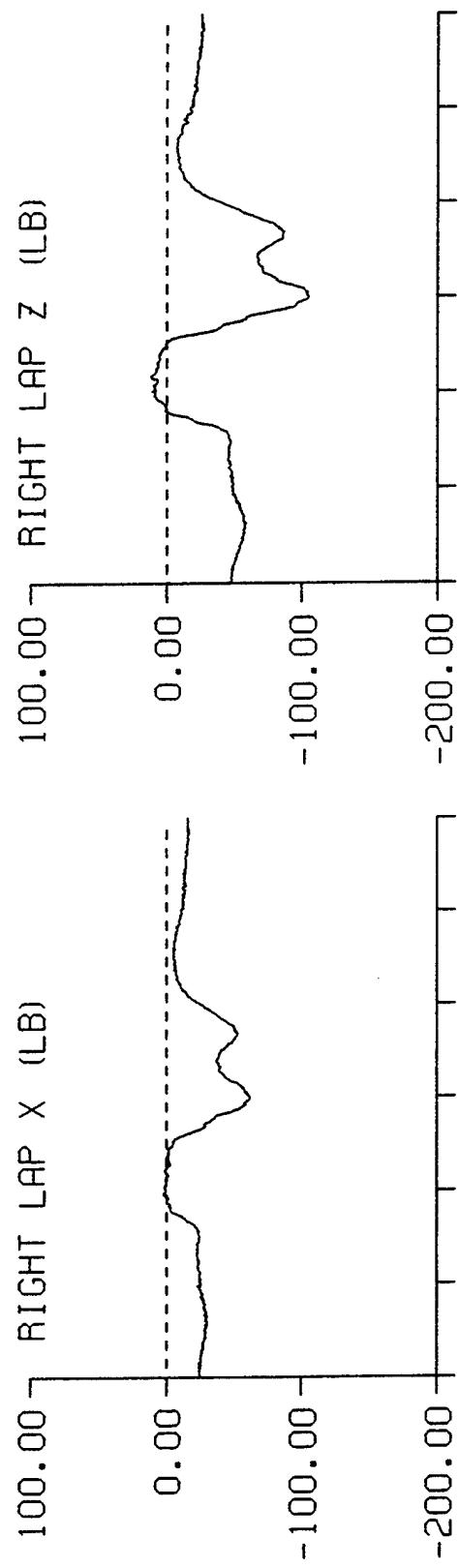




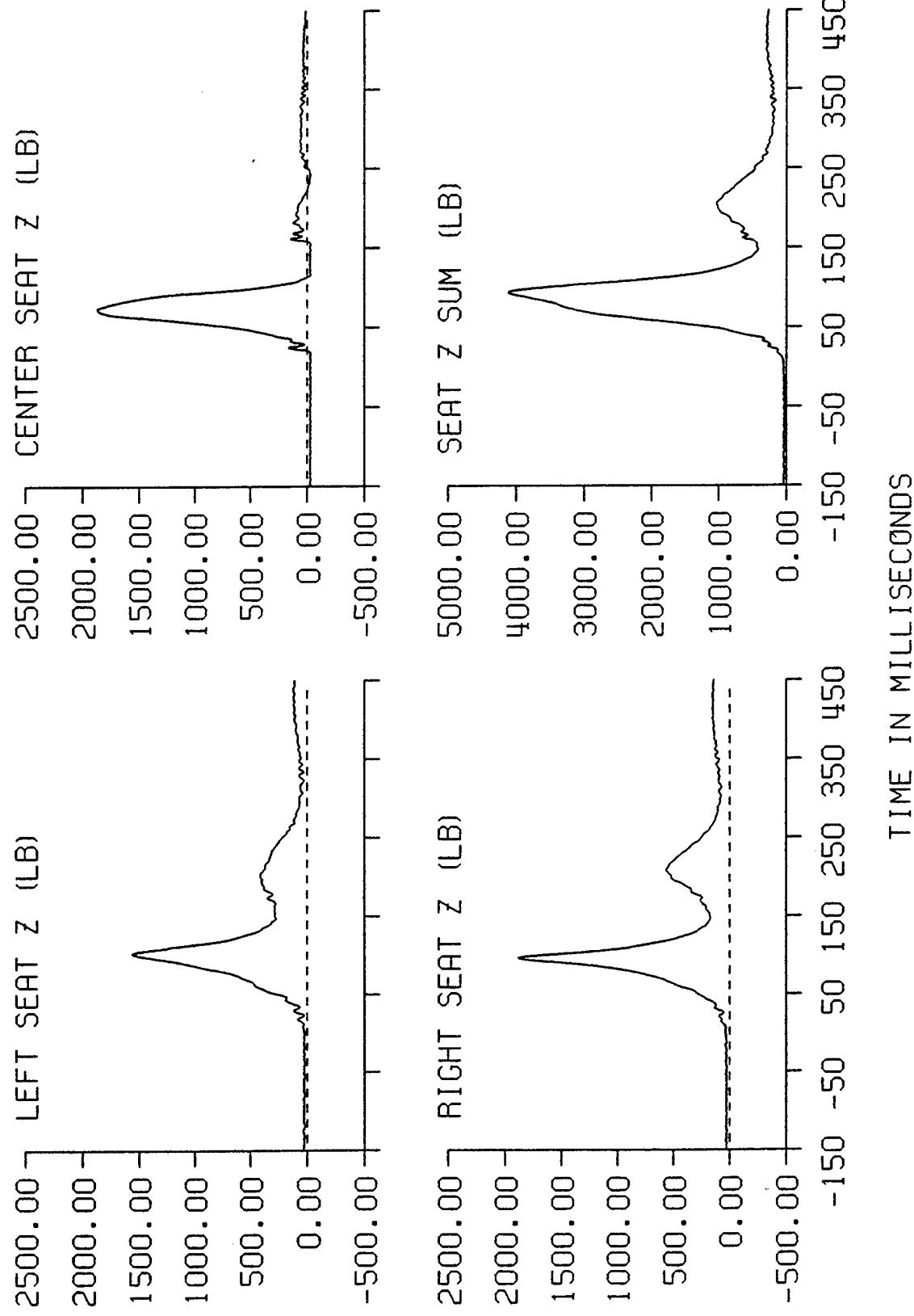
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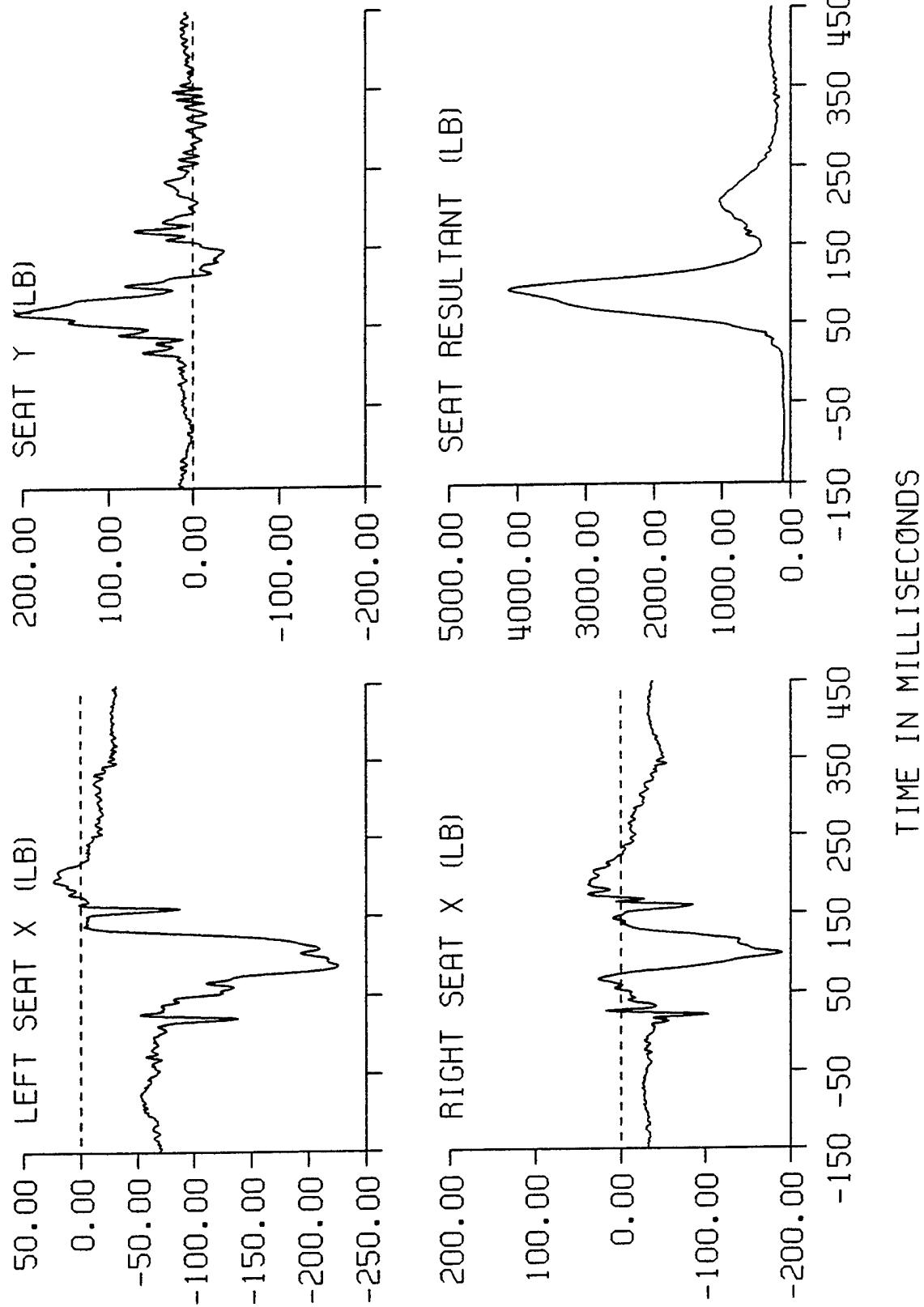
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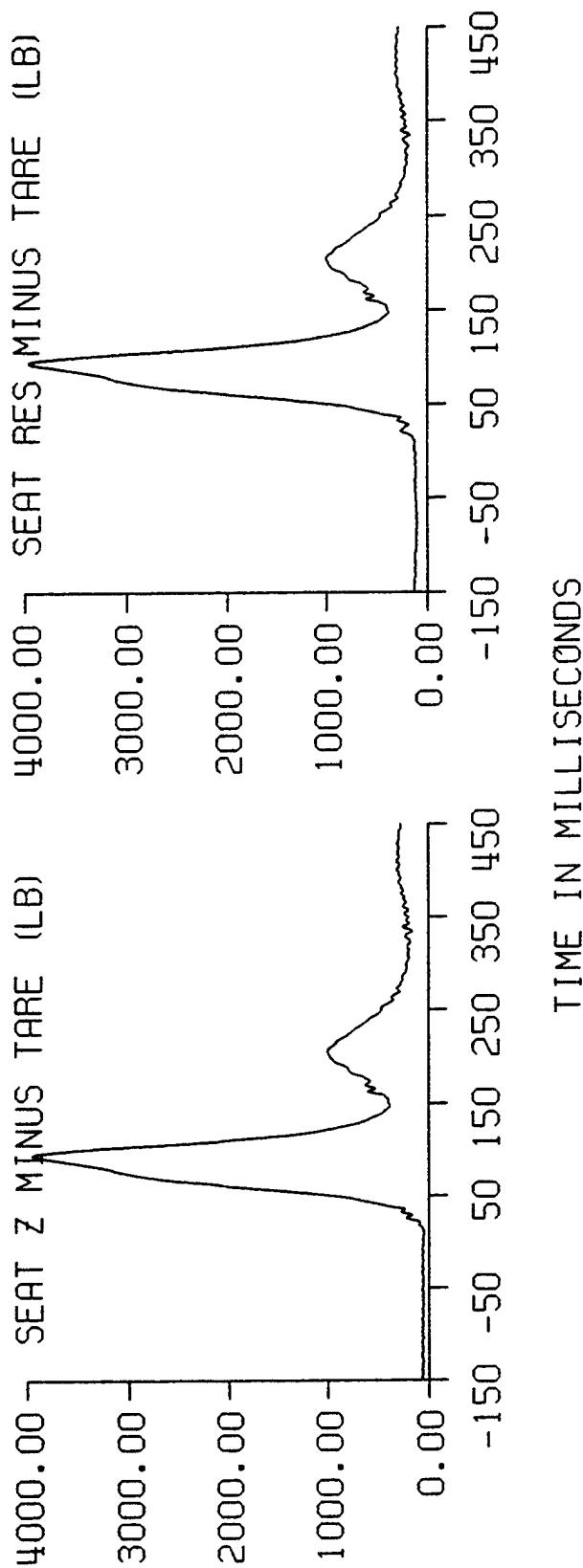
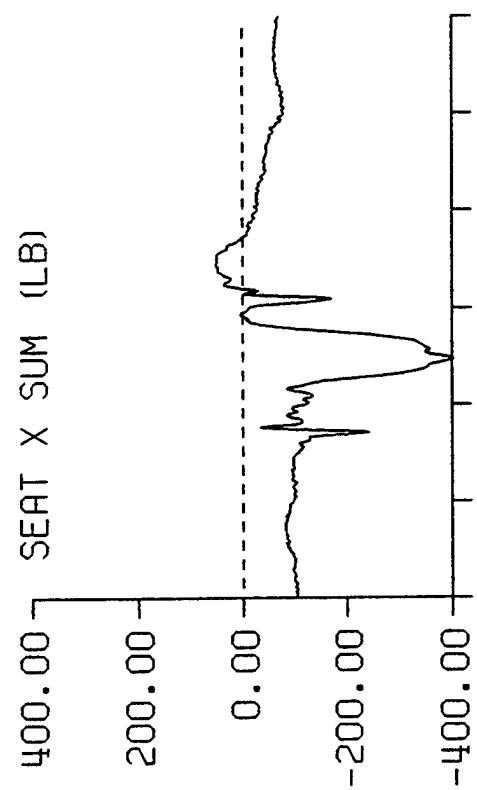
JMB STUDY TEST: 3848 SUBJ: JPAT-L CELL: D



JMB STUDY TEST: 3848 SUBJ: JPAT-L CELL: D



JMB STUDY TEST: 3848 SUBJ: JPAT-L CELL: D



JMB STUDY TEST: 3839 TEST DATE: 12-JUL-1997 SUBJ: JPAT-L WT: 253.0  
NOM G: 10.0 CELL: E

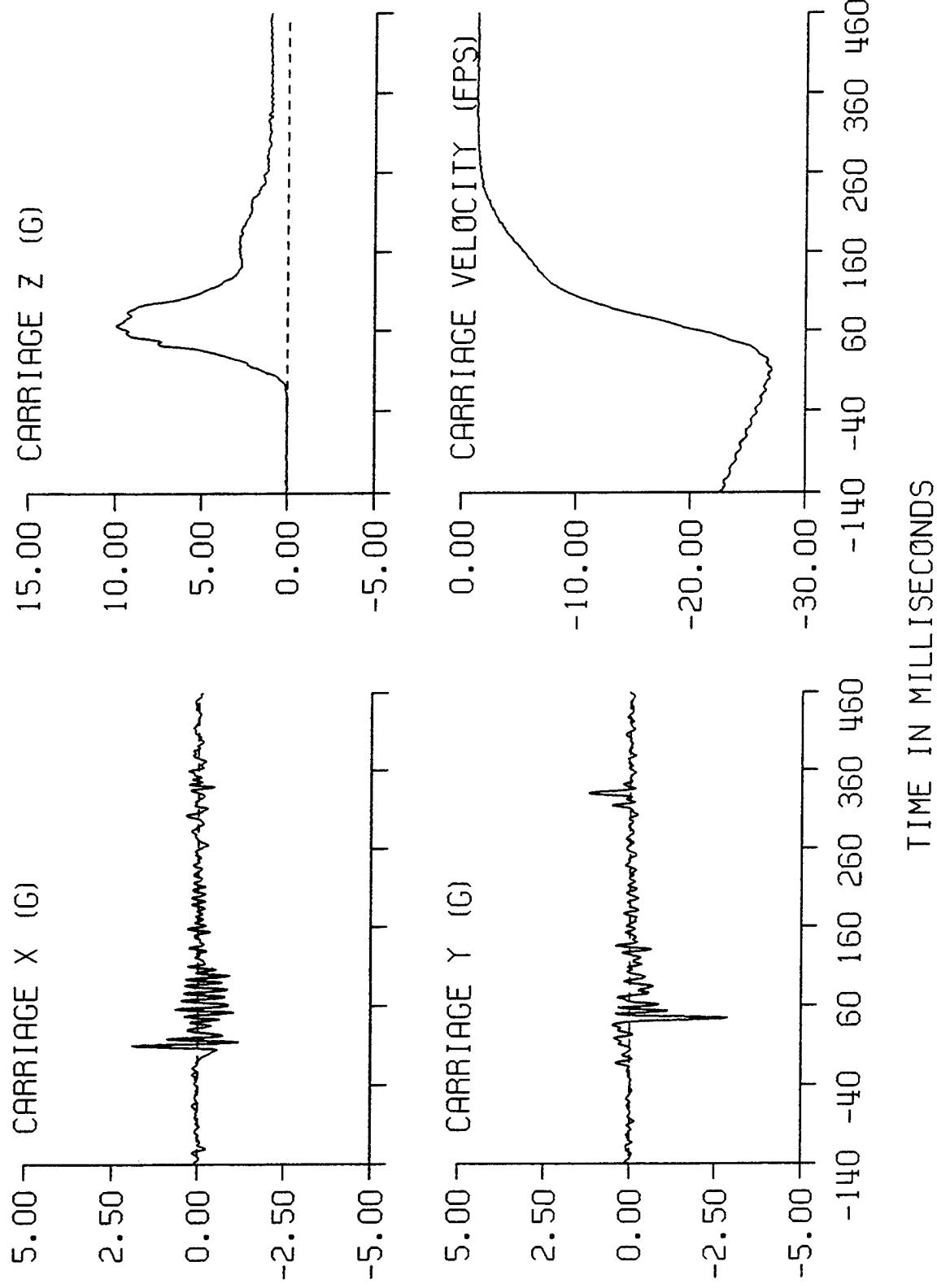
DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
REFERENCE MARK TIME (MS)				-143.	
CARRIAGE ACCELERATION (G)					
X AXIS	0.05	1.90	-1.21	10.	15.
Y AXIS	0.08	1.19	-2.87	330.	44.
Z AXIS	0.05	9.94	0.49	66.	0.
CARRIAGE VELOCITY (FPS)	-26.38	-1.22	-27.09	332.	9.
SEAT ACCELERATION (G)					
X AXIS	0.04	1.64	-1.03	10.	15.
Y AXIS	0.07	1.42	-2.35	64.	51.
Z AXIS	0.05	10.62	-0.43	68.	337.
EXT CHEST ACCELERATION (G)					
X AXIS	0.01	20.89	-3.49	96.	158.
Y AXIS	0.02	6.29	-2.93	100.	115.
Z AXIS	0.02	20.01	-2.89	92.	153.
RESULTANT	0.06	28.33	0.07	96.	3.
HEADREST FORCES (LB)					
UPPER X AXIS	-1.56	91.44	-11.72	215.	57.
LOWER X AXIS	-1.91	38.01	-4.94	213.	342.
X AXIS SUM	-3.46	127.46	-12.70	214.	342.
SHOULDER FORCES (LB)					
X AXIS	-15.37	4.65	-184.06	241.	96.
Y AXIS	3.13	37.18	-3.74	85.	45.
Z AXIS	1.83	125.11	-8.61	93.	165.
RESULTANT	15.94	221.96	2.39	93.	272.
LAP FORCES (LB)					
LEFT X AXIS	-14.62	3.88	-55.65	48.	231.
LEFT Y AXIS	2.28	9.85	-6.42	221.	65.
LEFT Z AXIS	-29.63	15.48	-81.96	61.	231.
LEFT RESULTANT	33.13	99.36	1.96	231.	386.
RIGHT X AXIS	-7.87	7.18	-40.49	73.	231.
RIGHT Y AXIS	-3.85	5.74	-14.06	71.	240.
RIGHT Z AXIS	-14.50	18.14	-58.21	73.	231.
RIGHT RESULTANT	16.95	72.15	0.81	231.	19.

JMB STUDY TEST: 3839 TEST DATE: 12-JUL-1997 SUBJ: JPAT-L WT: 253.0  
NOM G: 10.0 CELL: E

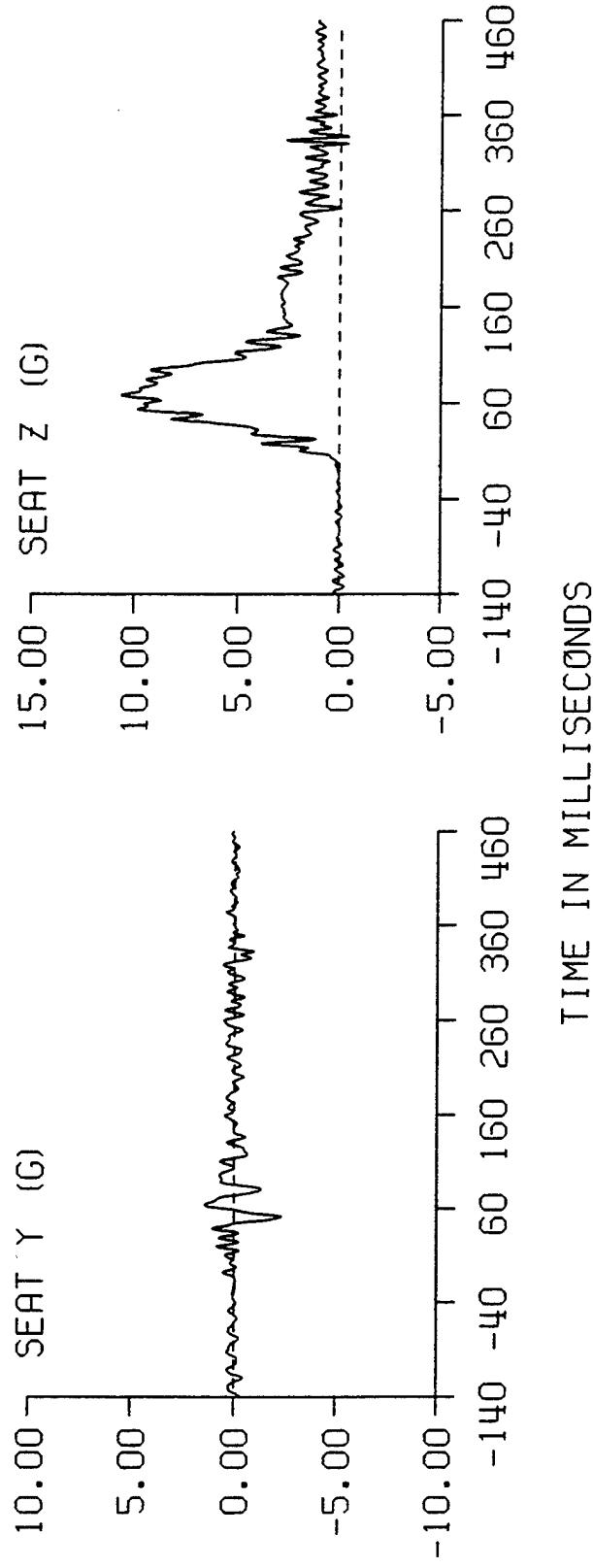
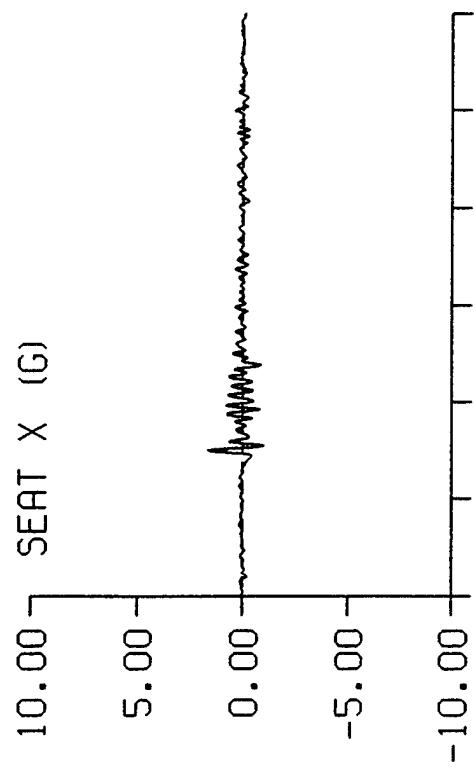
DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
SEAT FORCES (LB)					
LEFT X AXIS	-33.13	88.28	-243.81	213.	105.
RIGHT X AXIS	-34.63	83.28	-244.80	71.	102.
X AXIS SUM	-67.76	122.02	-486.73	204.	103.
Y AXIS	12.33	235.22	-93.66	70.	106.
LEFT Z AXIS	8.68	1553.46	-0.77	101.	23.
RIGHT Z AXIS	9.96	1902.56	0.71	97.	1.
CENTER Z AXIS	-23.14	2230.94	-47.91	77.	27.
Z AXIS SUM	-4.50	4402.77	-8.25	94.	2.
RESULTANT	69.12	4418.17	50.98	94.	10.
Z SUM MINUS TARE	19.85	4226.01	-19.45	95.	26.
RESULTANT MINUS TARE	71.80	4243.98	48.70	95.	10.

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JMB STUDY TEST: 3839 SUBJ: JPAT-L CELL: E

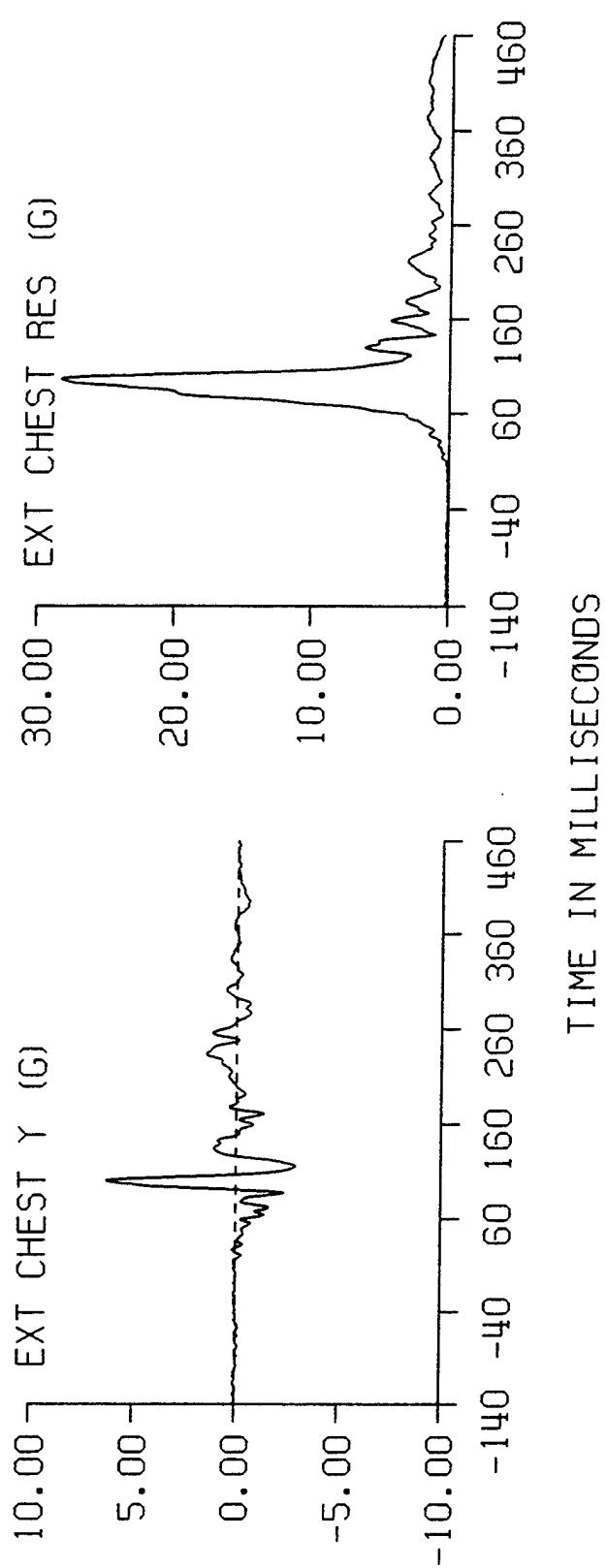
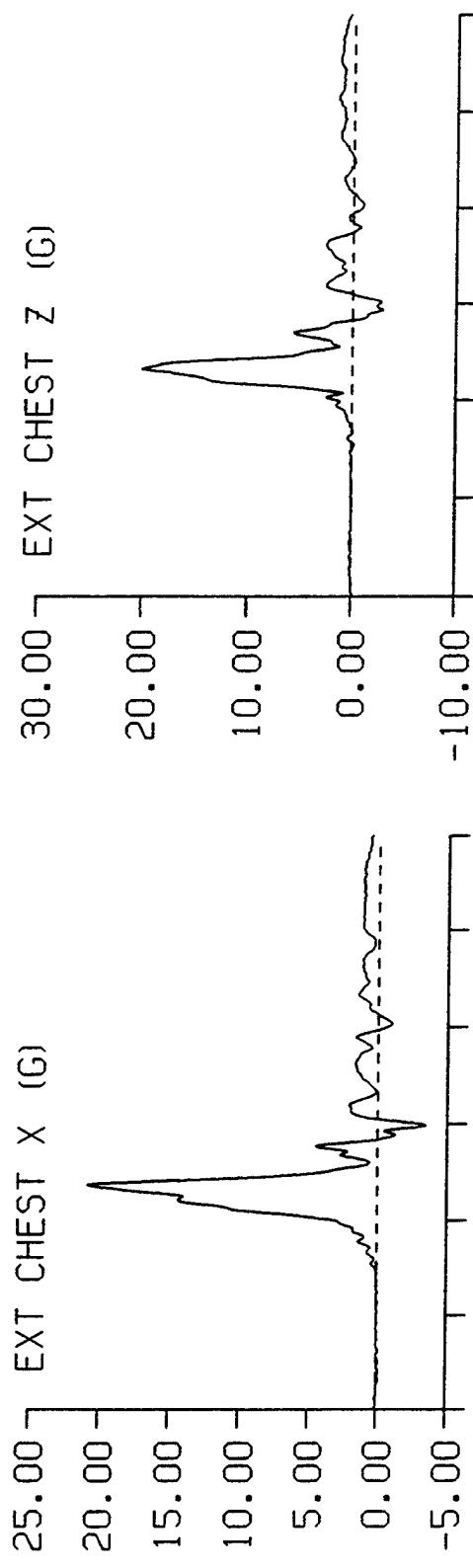


JMB STUDY TEST: 3839 SUBJ: JPAT-L CELL: E

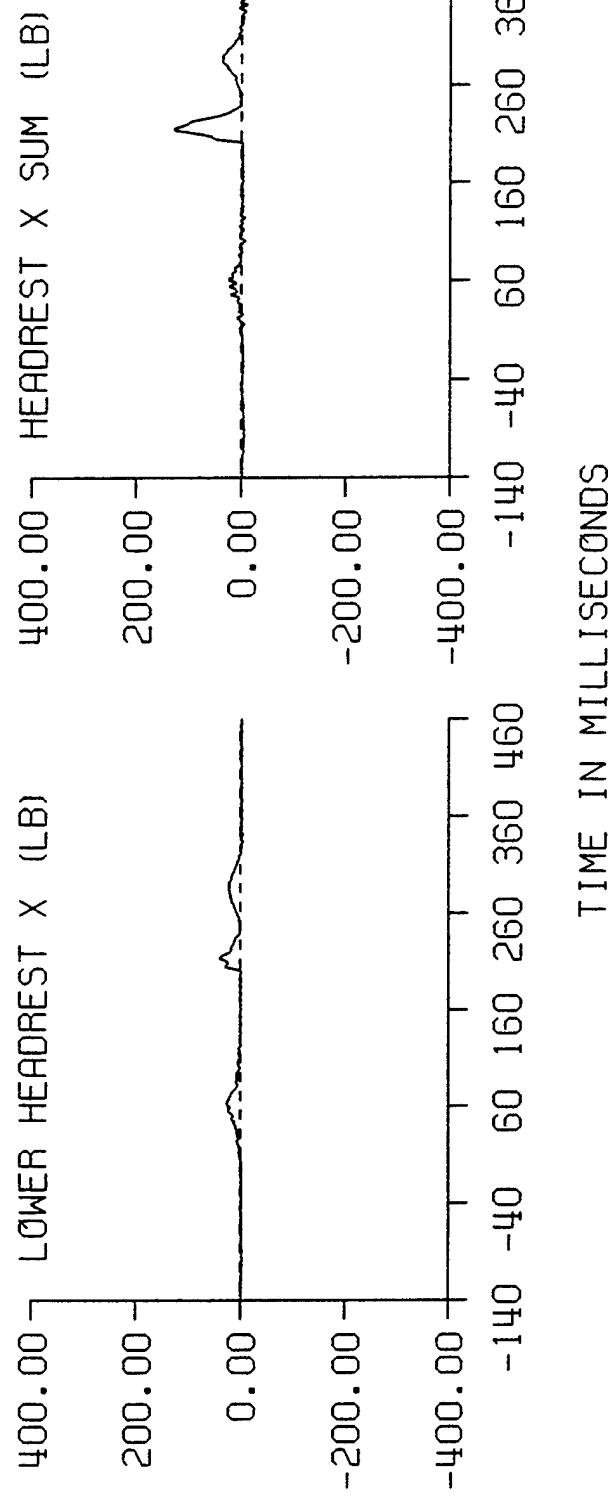
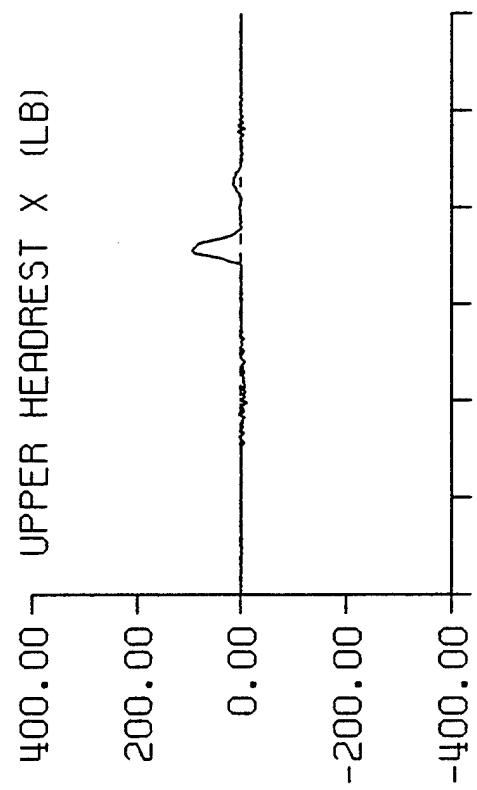


TIME IN MILLISECONDS

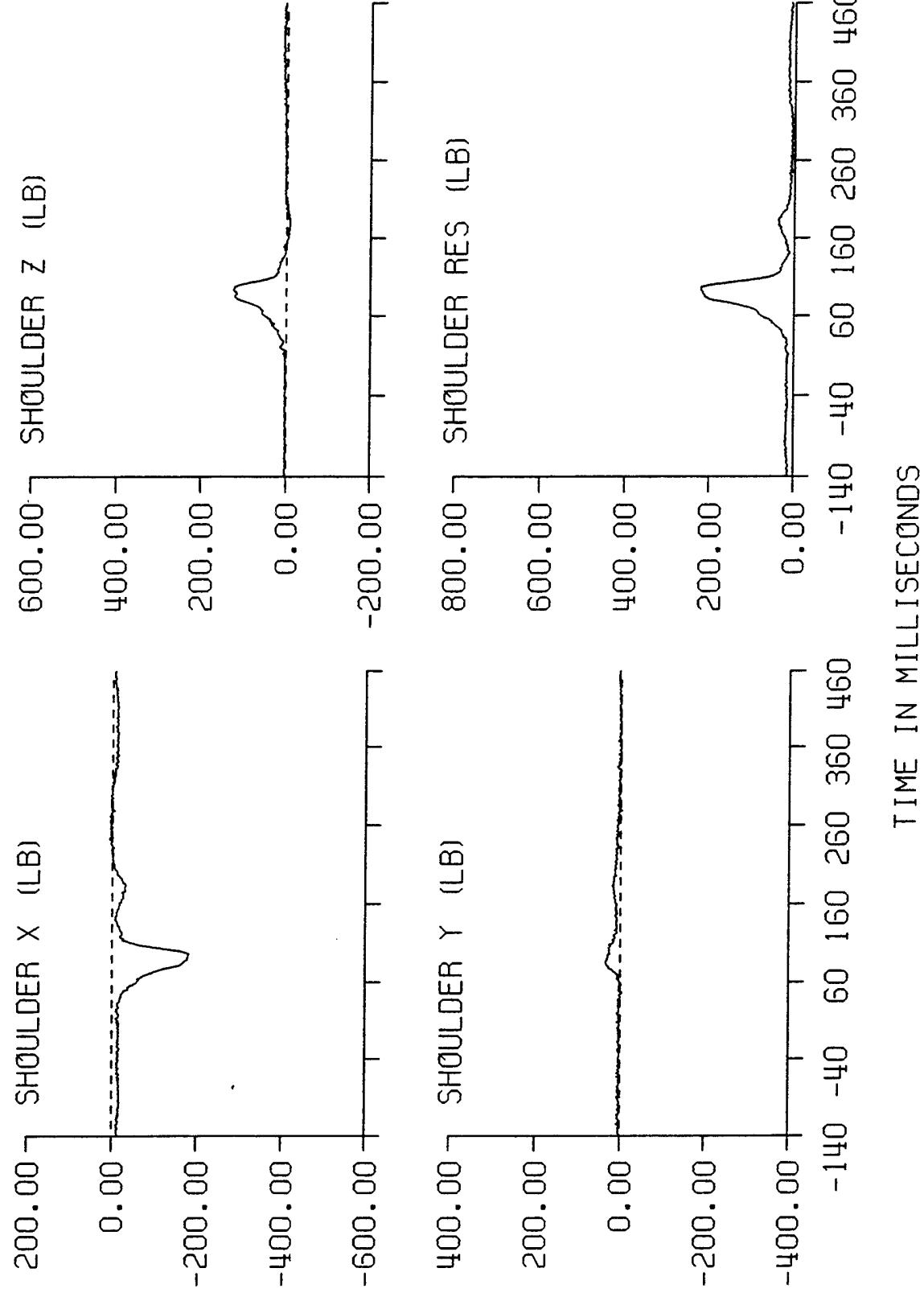
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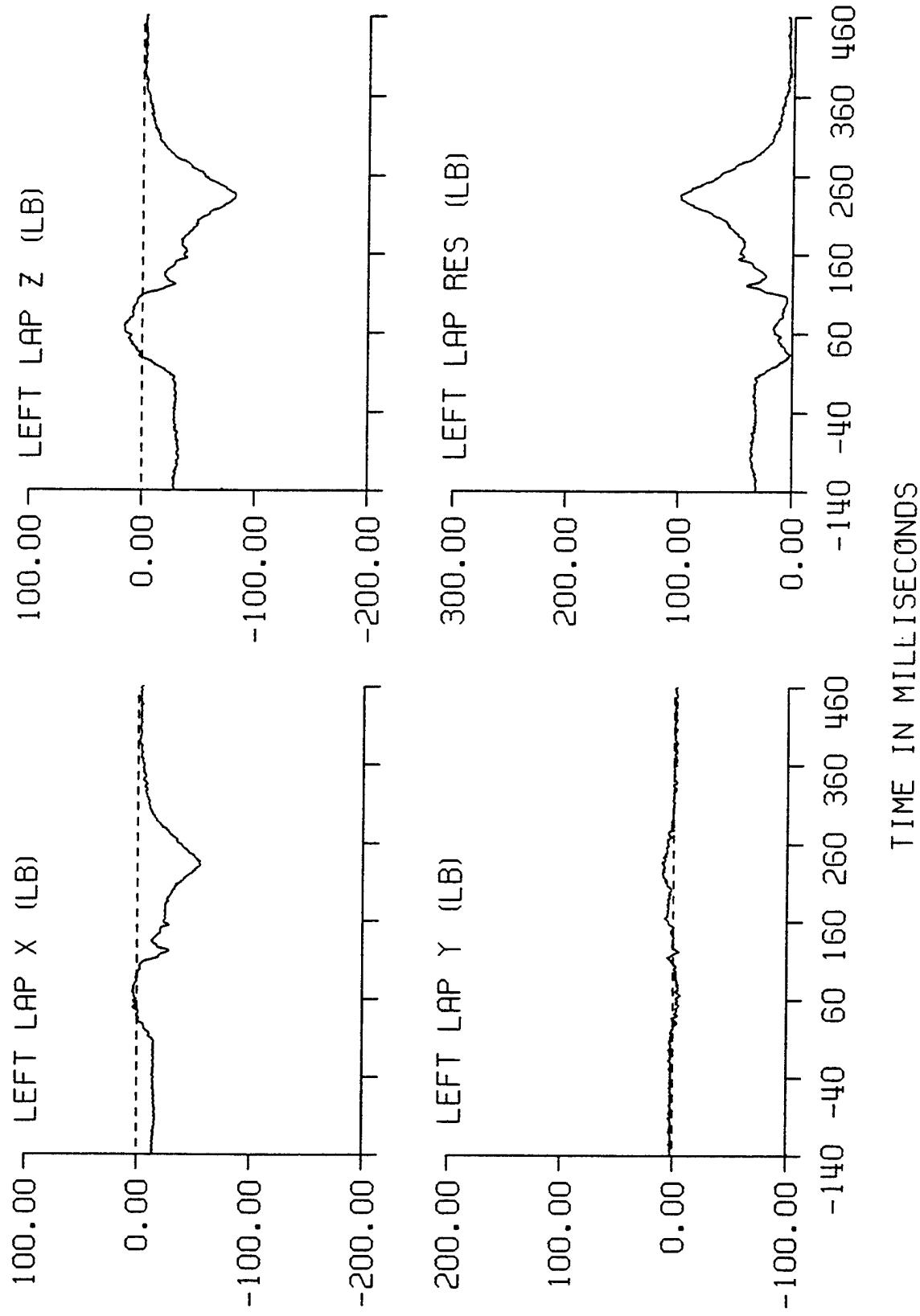
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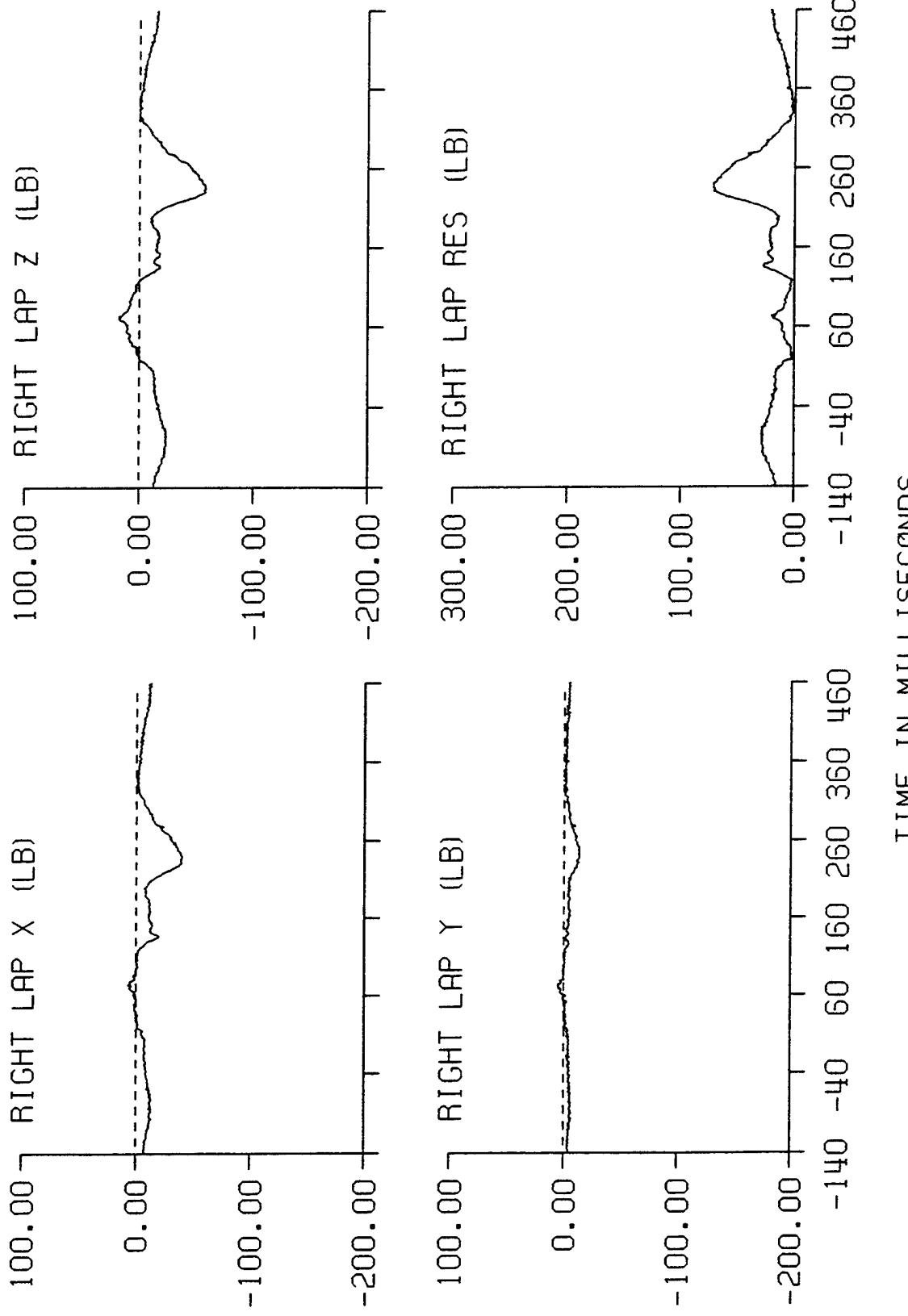
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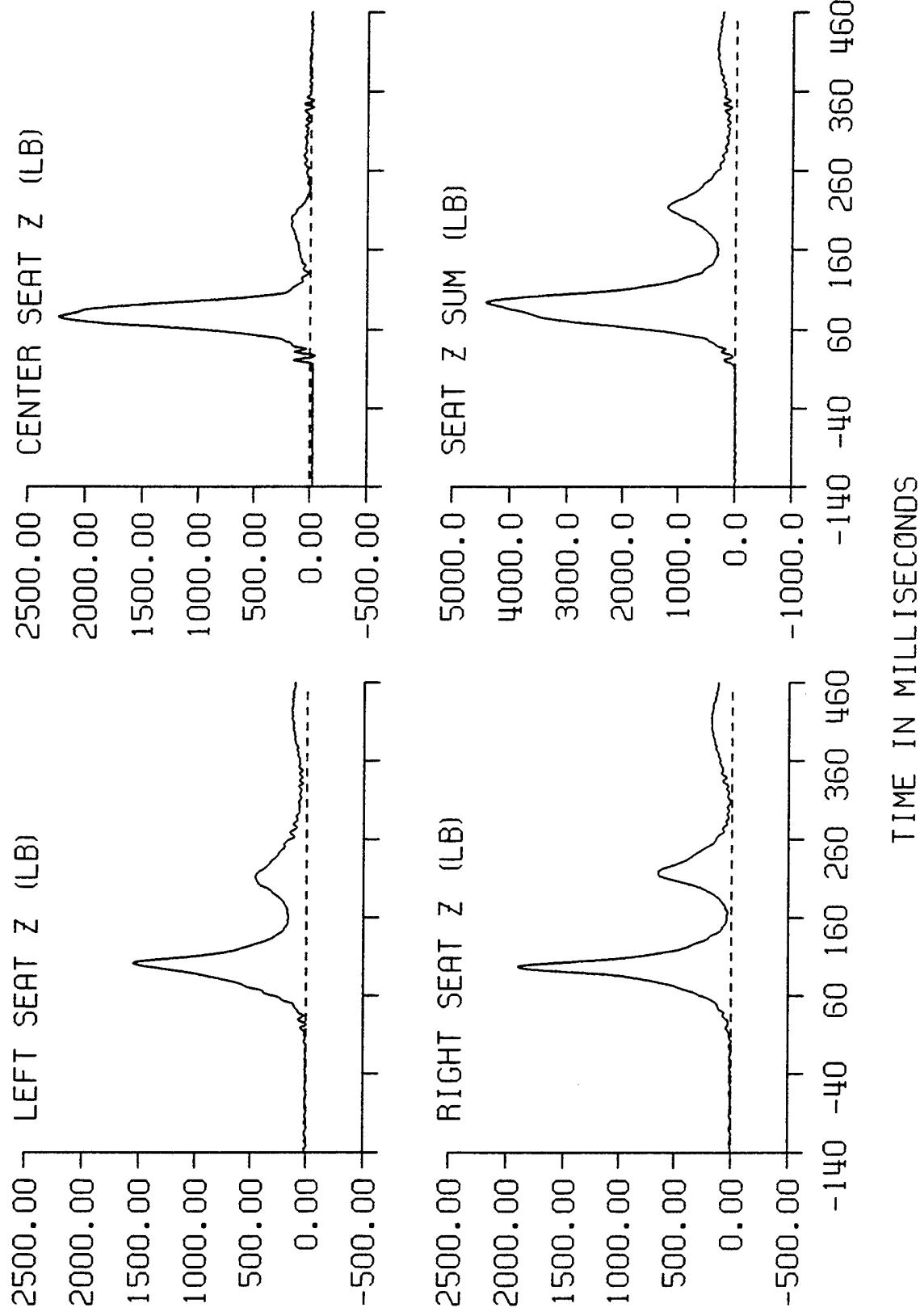
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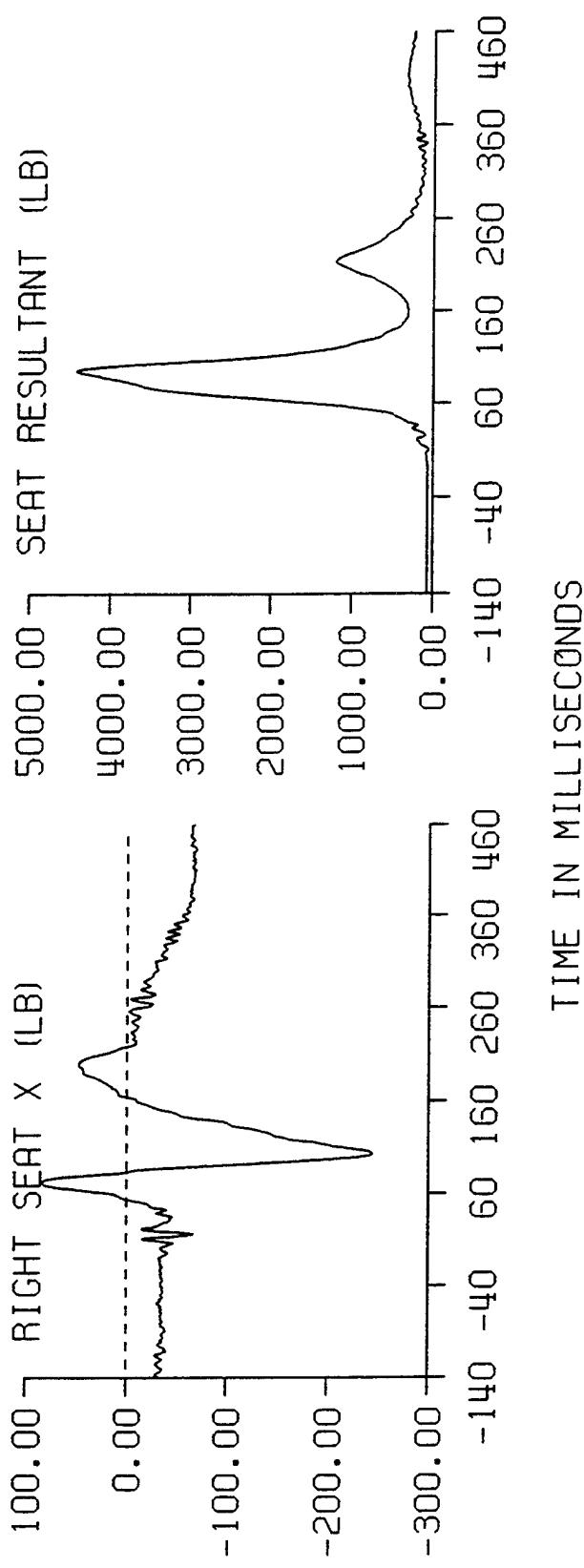
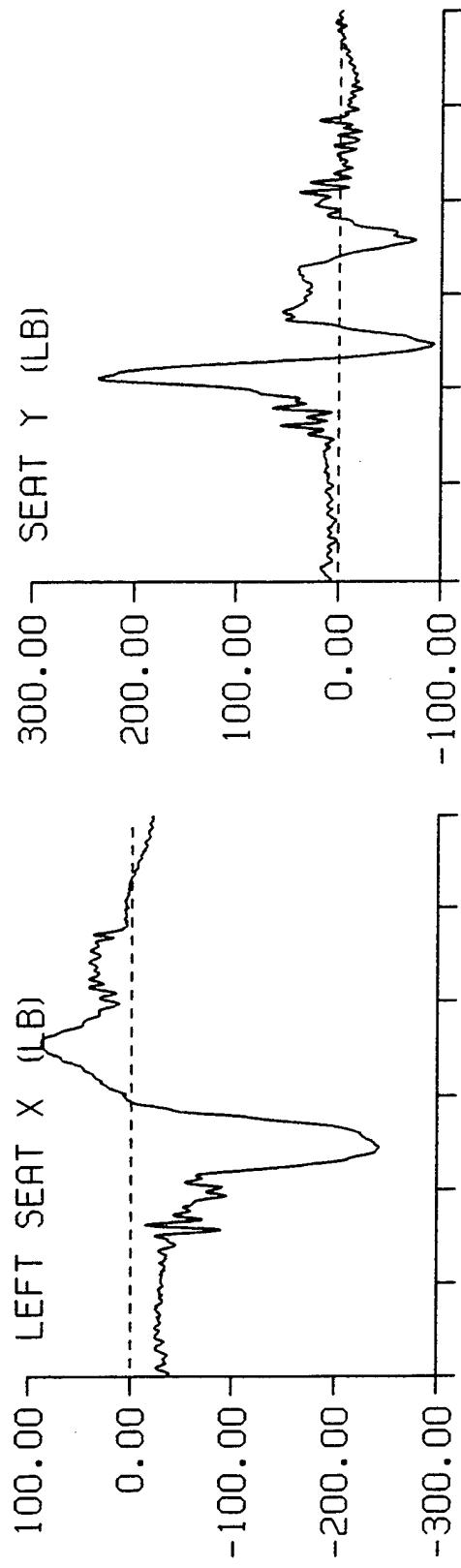
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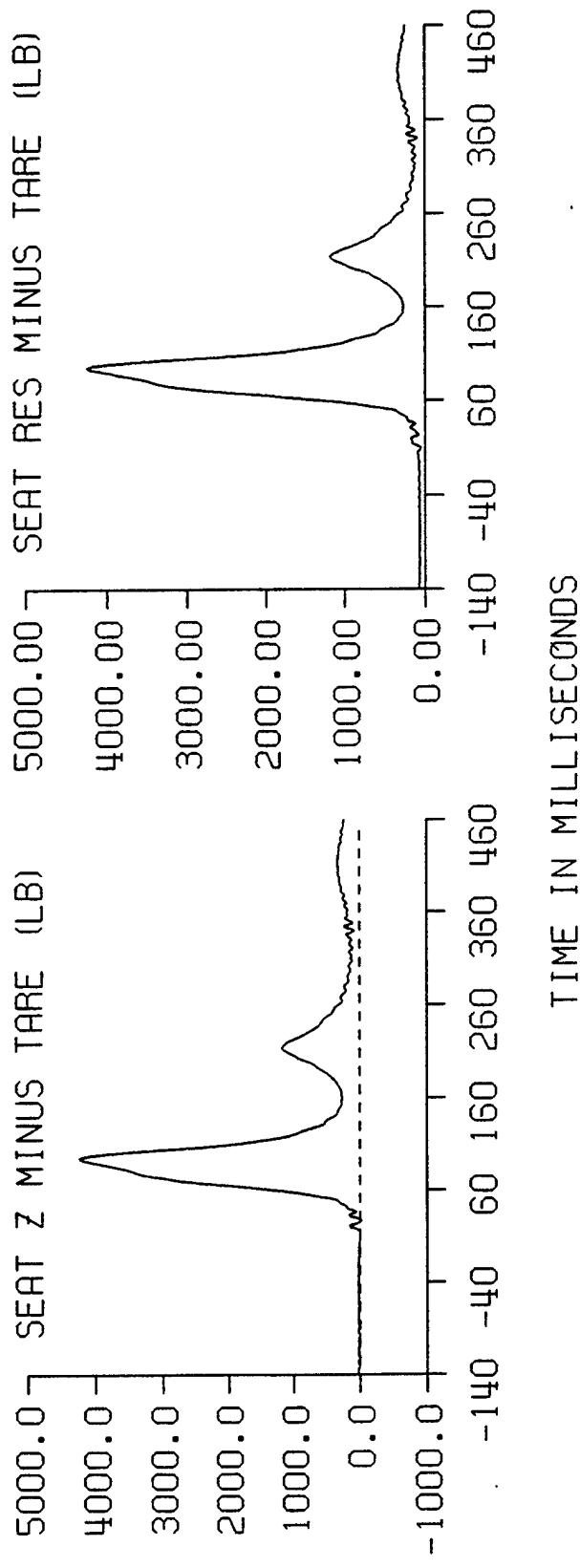
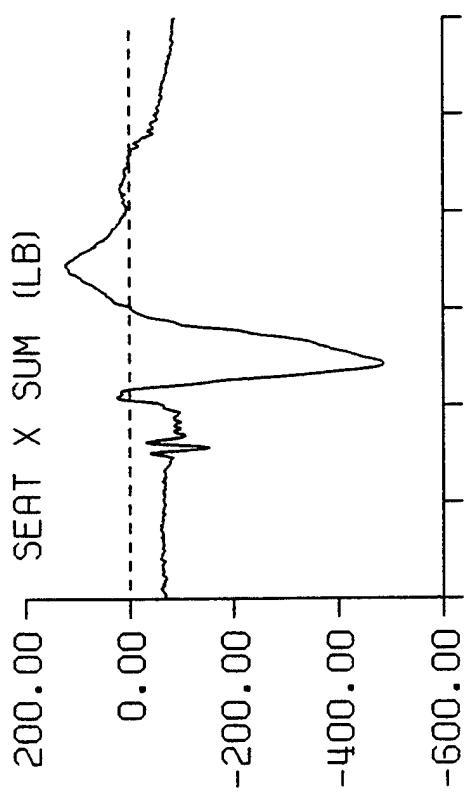
JMB STUDY TEST: 3839 SUBJ: JPAT-L CELL: E



JMB STUDY TEST: 3839 SUBJ: JPAT-L CELL: E



JMB STUDY TEST: 3839 SUBJ: JPAT-L CELL: E



JMB STUDY TEST: 3840 TEST DATE: 13-JUL-1997 SUBJ: JPAT-L WT: 258.0  
 NOM G: 10.0 CELL: F

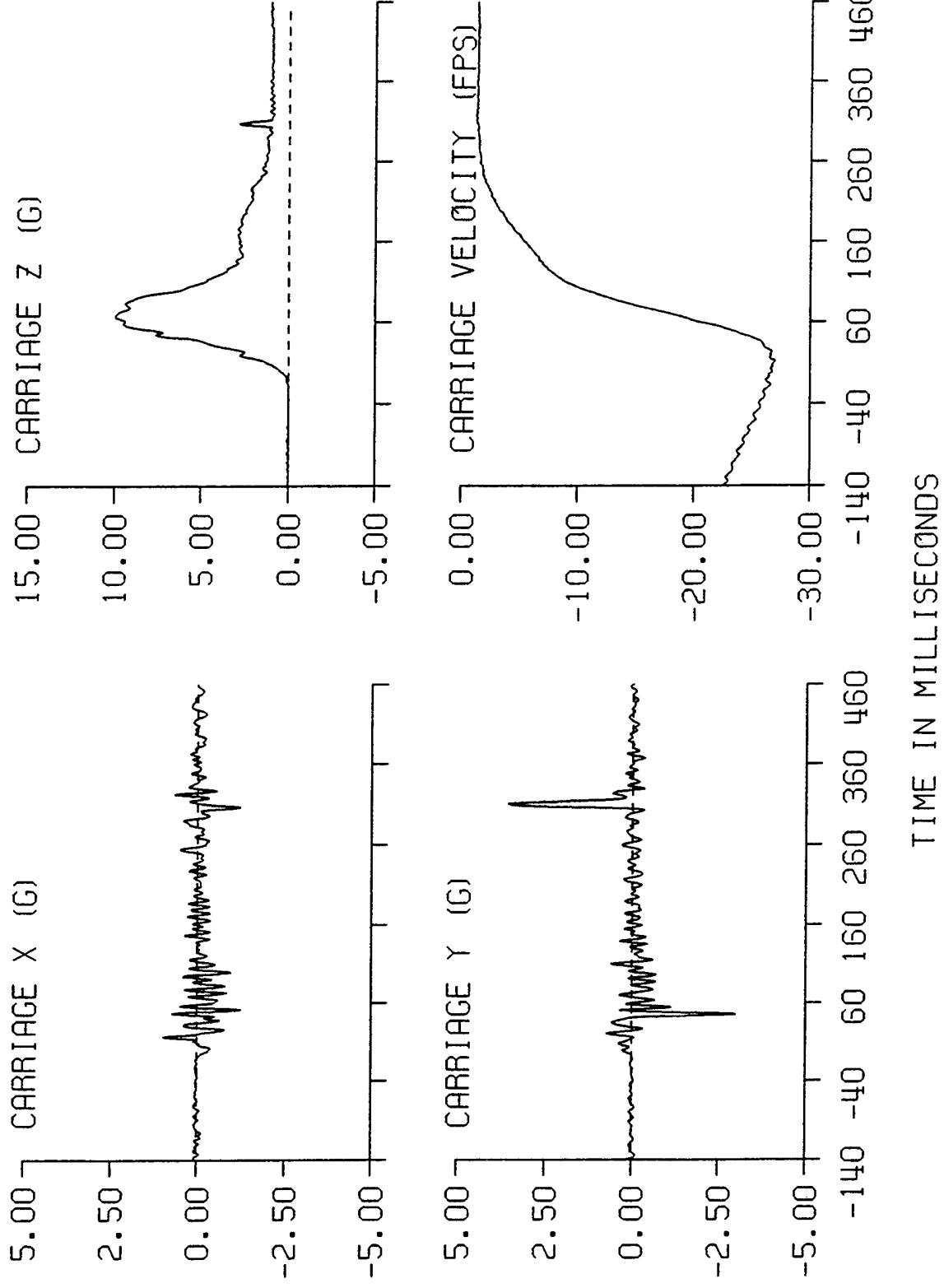
DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
REFERENCE MARK TIME (MS)				-142.	
CARRIAGE ACCELERATION (G)					
X AXIS	0.00	0.99	-1.26	17.	52.
Y AXIS	0.00	3.56	-3.01	310.	45.
Z AXIS	0.04	9.95	0.48	67.	0.
CARRIAGE VELOCITY (FPS)	-26.34	-1.23	-27.00	310.	11.
SEAT ACCELERATION (G)					
X AXIS	0.00	1.46	-1.16	310.	100.
Y AXIS	0.02	2.02	-2.85	64.	51.
Z AXIS	0.03	11.33	-1.36	71.	319.
EXT CHEST ACCELERATION (G)					
X AXIS	-0.01	26.51	-2.31	100.	164.
Y AXIS	0.01	7.37	-1.92	96.	329.
Z AXIS	0.01	23.21	-3.39	99.	118.
RESULTANT	0.04	35.40	0.02	99.	0.
HEADREST FORCES (LB)					
UPPER X AXIS	3.18	44.42	-6.17	262.	58.
LOWER X AXIS	-3.56	29.05	-7.00	57.	359.
X AXIS SUM	-0.38	50.75	-8.70	260.	359.
SHOULDER FORCES (LB)					
X AXIS	-13.91	-1.93	-187.50	304.	97.
Y AXIS	-8.47	14.28	-17.35	94.	327.
Z AXIS	-16.99	95.30	-24.24	94.	177.
RESULTANT	23.60	206.31	9.92	98.	26.
LAP FORCES (LB)					
LEFT X AXIS	-22.13	1.86	-49.16	74.	239.
LEFT Y AXIS	2.40	10.10	-5.42	234.	51.
LEFT Z AXIS	-44.73	11.90	-78.94	70.	242.
LEFT RESULTANT	49.97	93.47	1.76	242.	38.
RIGHT X AXIS	-16.39	6.66	-43.11	74.	240.
RIGHT Y AXIS	-9.01	7.26	-15.47	72.	244.
RIGHT Z AXIS	-32.32	18.97	-61.74	74.	244.
RIGHT RESULTANT	37.35	76.48	1.87	244.	106.

JMB STUDY TEST: 3840 TEST DATE: 13-JUL-1997 SUBJ: JPAT-L WT: 258.0  
NOM G: 10.0 CELL: F

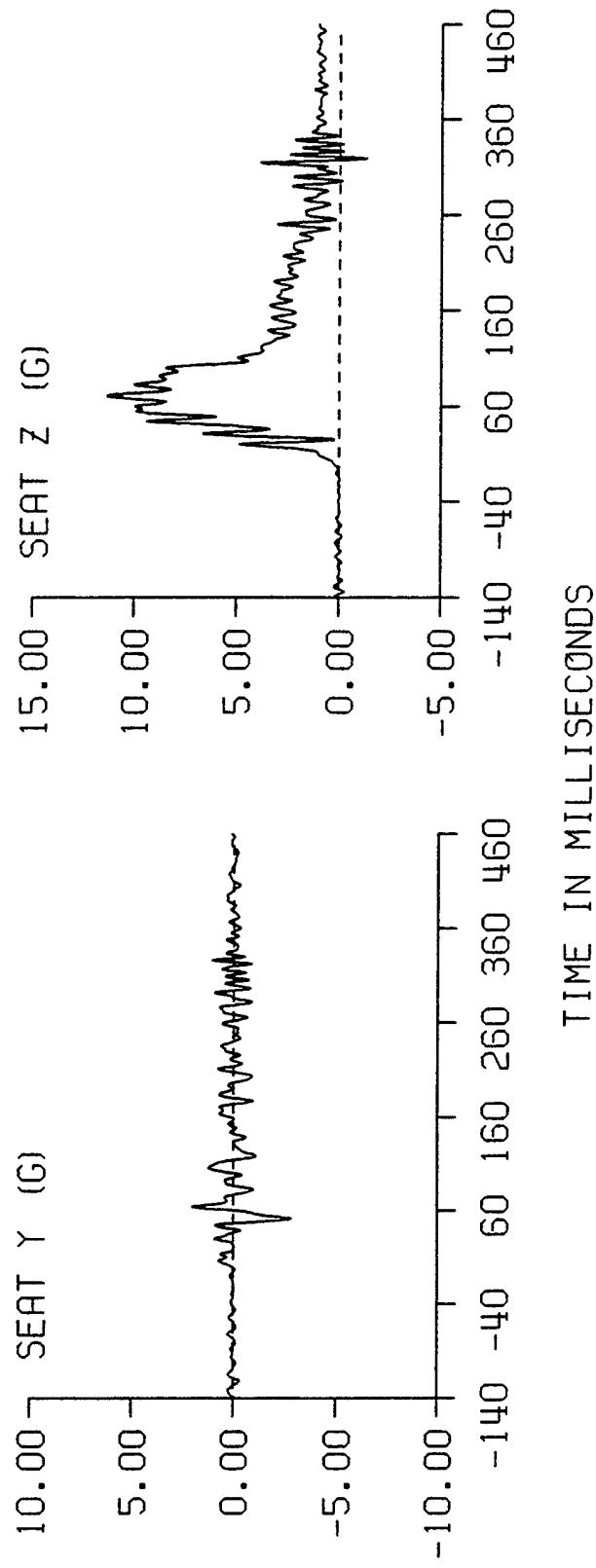
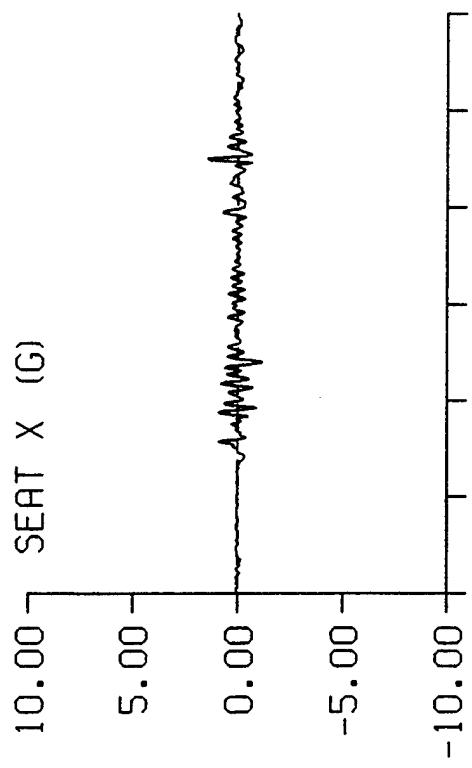
DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
SEAT FORCES (LB)					
LEFT X AXIS	-32.17	66.12	-266.91	311.	103.
RIGHT X AXIS	-19.50	64.93	-254.53	206.	107.
X AXIS SUM	-51.66	101.93	-519.56	205.	107.
Y AXIS	1.79	147.59	-170.29	74.	103.
LEFT Z AXIS	6.20	1867.88	-0.12	97.	7.
RIGHT Z AXIS	4.40	1856.16	-10.29	100.	311.
CENTER Z AXIS	-25.77	1736.51	-20.93	78.	0.
Z AXIS SUM	-15.17	4541.16	-8.15	97.	5.
RESULTANT	54.02	4563.03	25.70	97.	320.
Z SUM MINUS TARE	9.58	4386.09	-40.84	97.	26.
RESULTANT MINUS TARE	52.77	4408.72	28.14	97.	320.

Page 2 of 2

JMB STUDY TEST: 3840 SUBJ: JPAT-L CELL: F

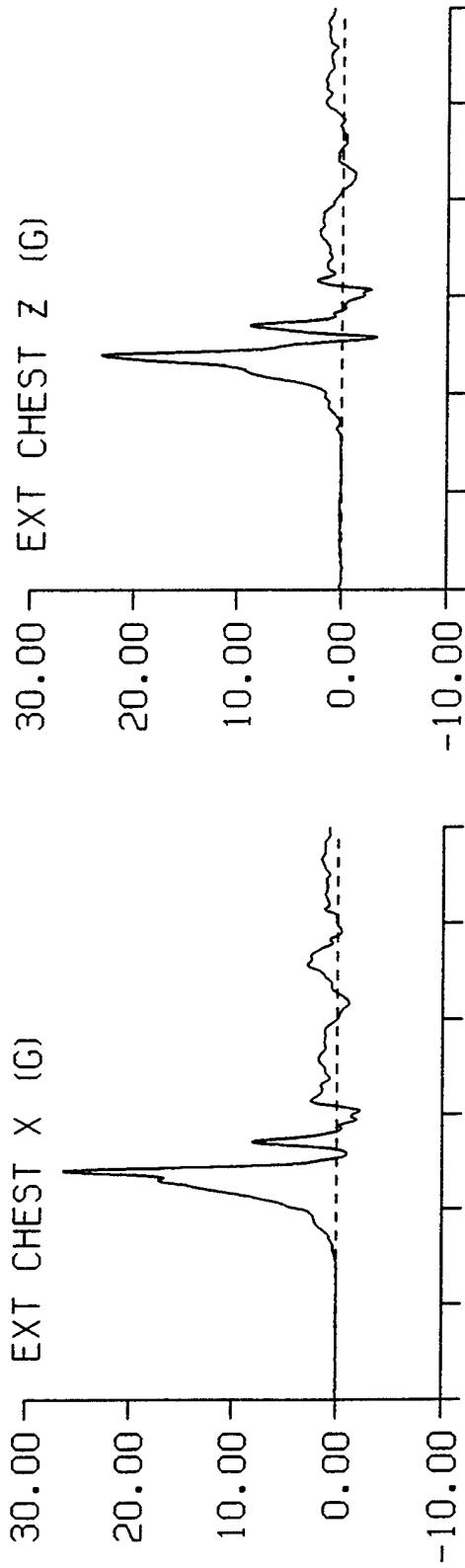


JMB STUDY TEST: 3840 SUBJ: JPAT-L CELL: F



TIME IN MILLISECONDS

JMB STUDY TEST: 3840 SUBJ: JPAT-L CELL: F



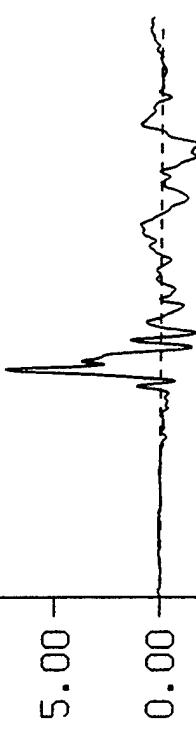
10.00 EXT CHEST Y (G)

5.00

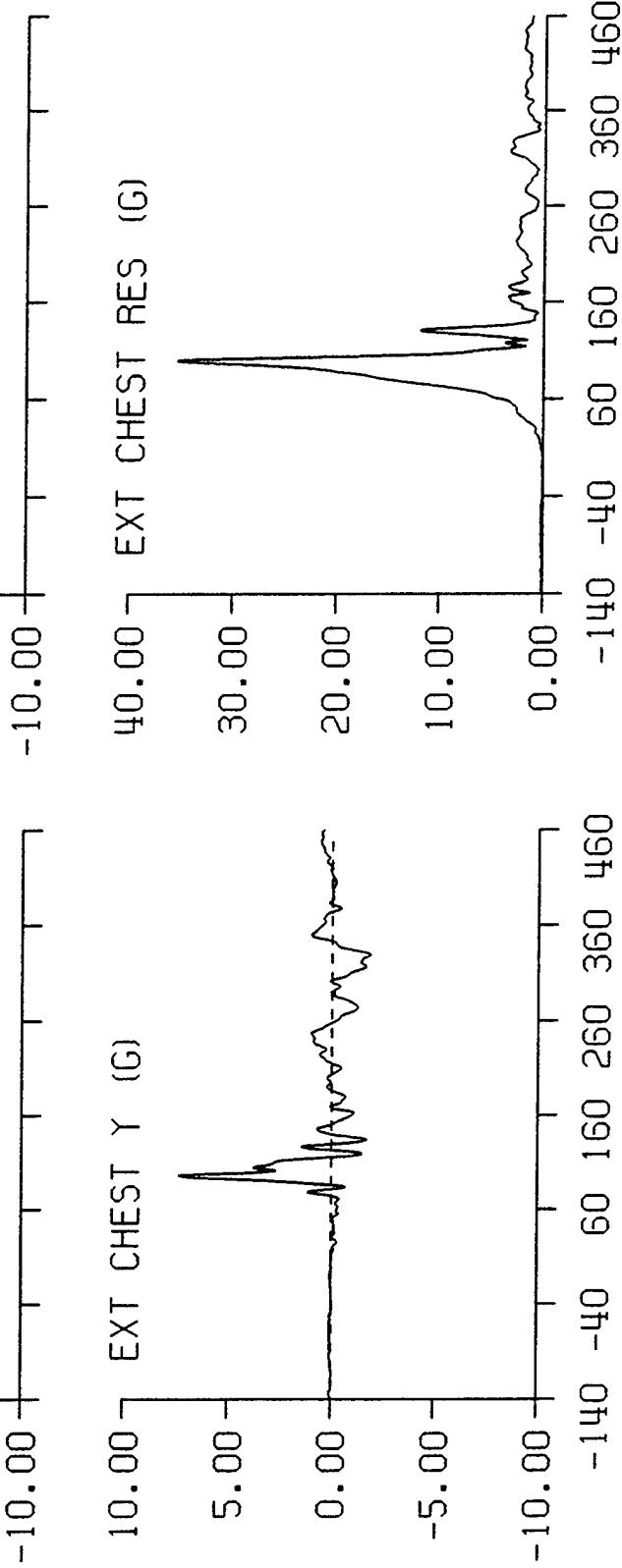
0.00

-5.00

-10.00

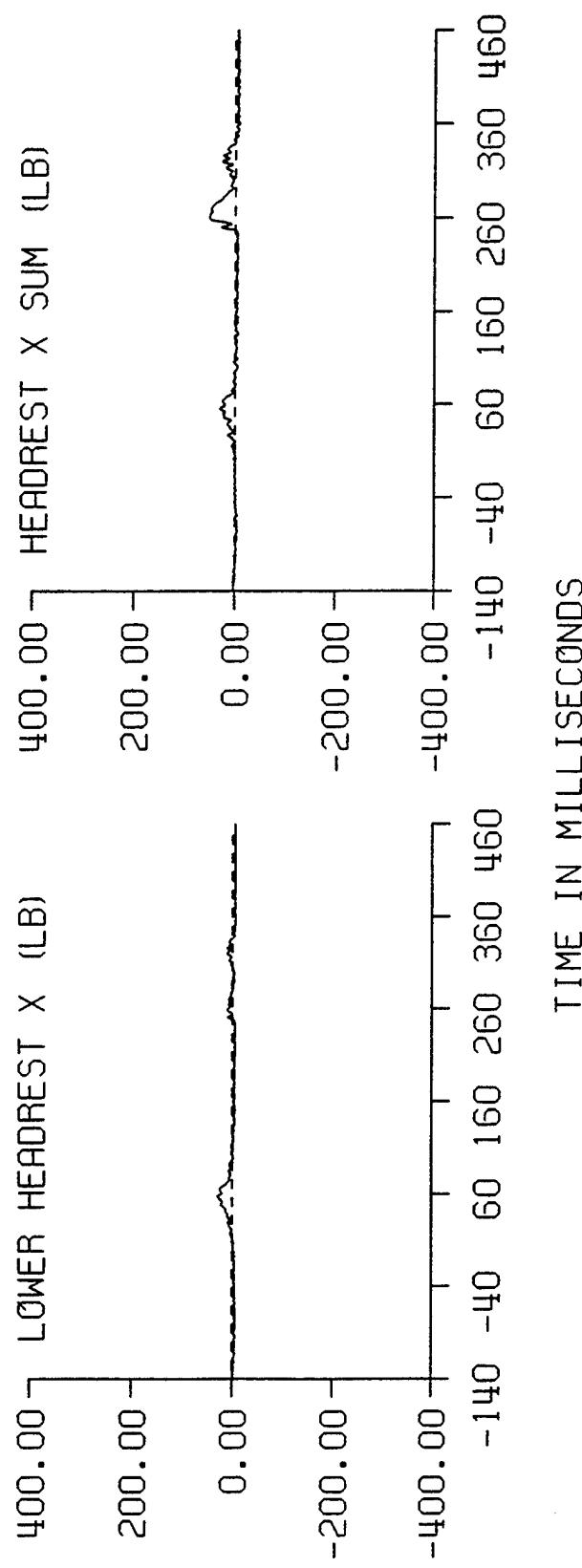
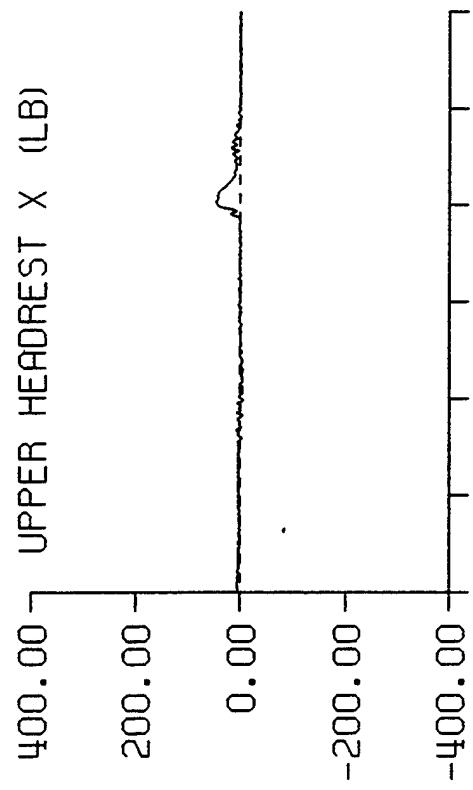


B-77  
120

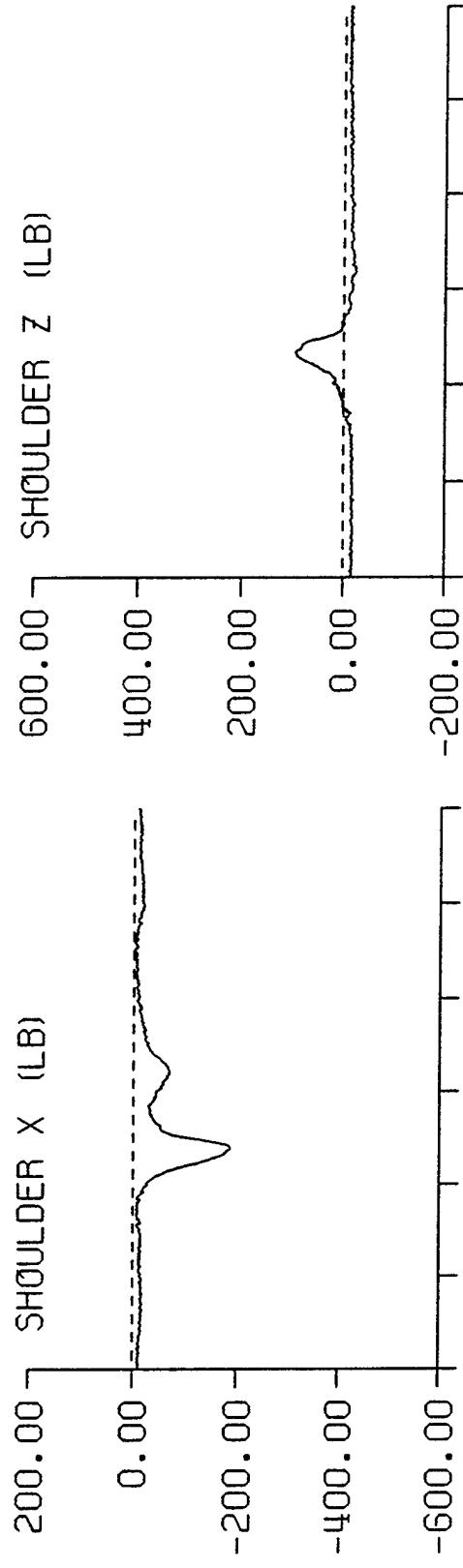


TIME IN MILLISECONDS

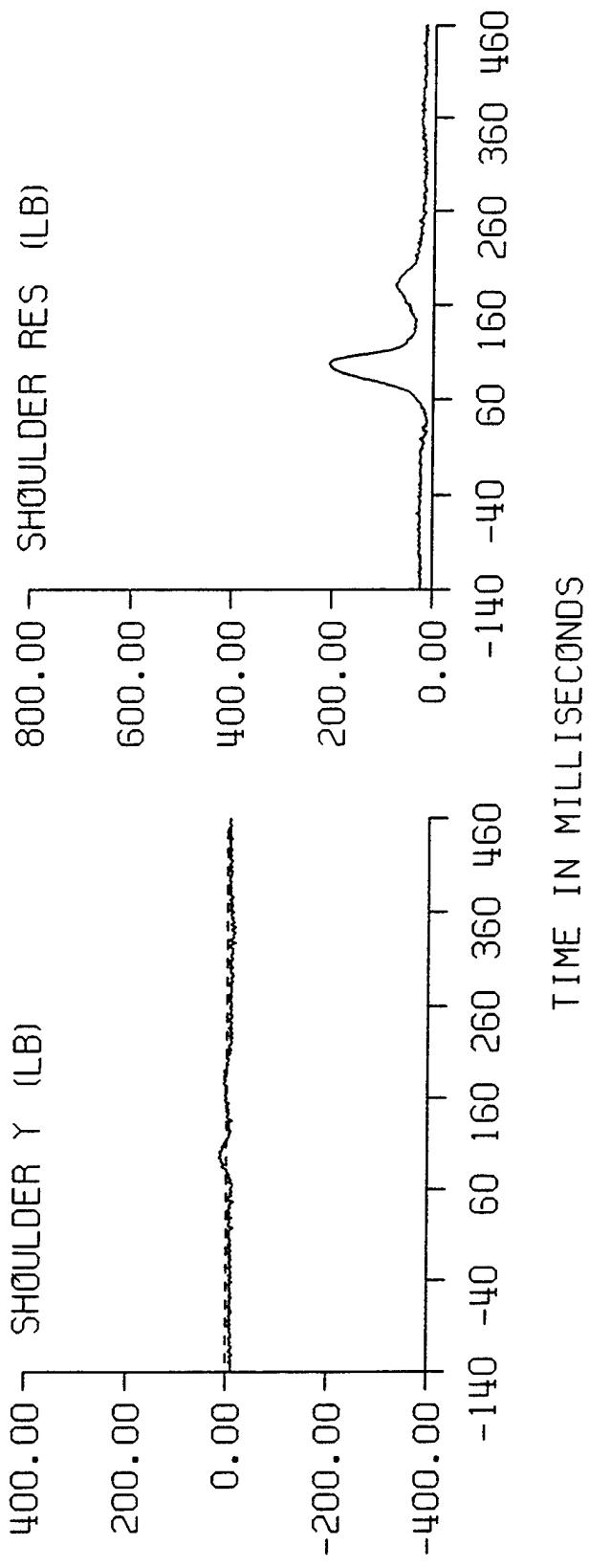
JMB STUDY TEST: 3840 SUBJ: JPAT-L CELL: F



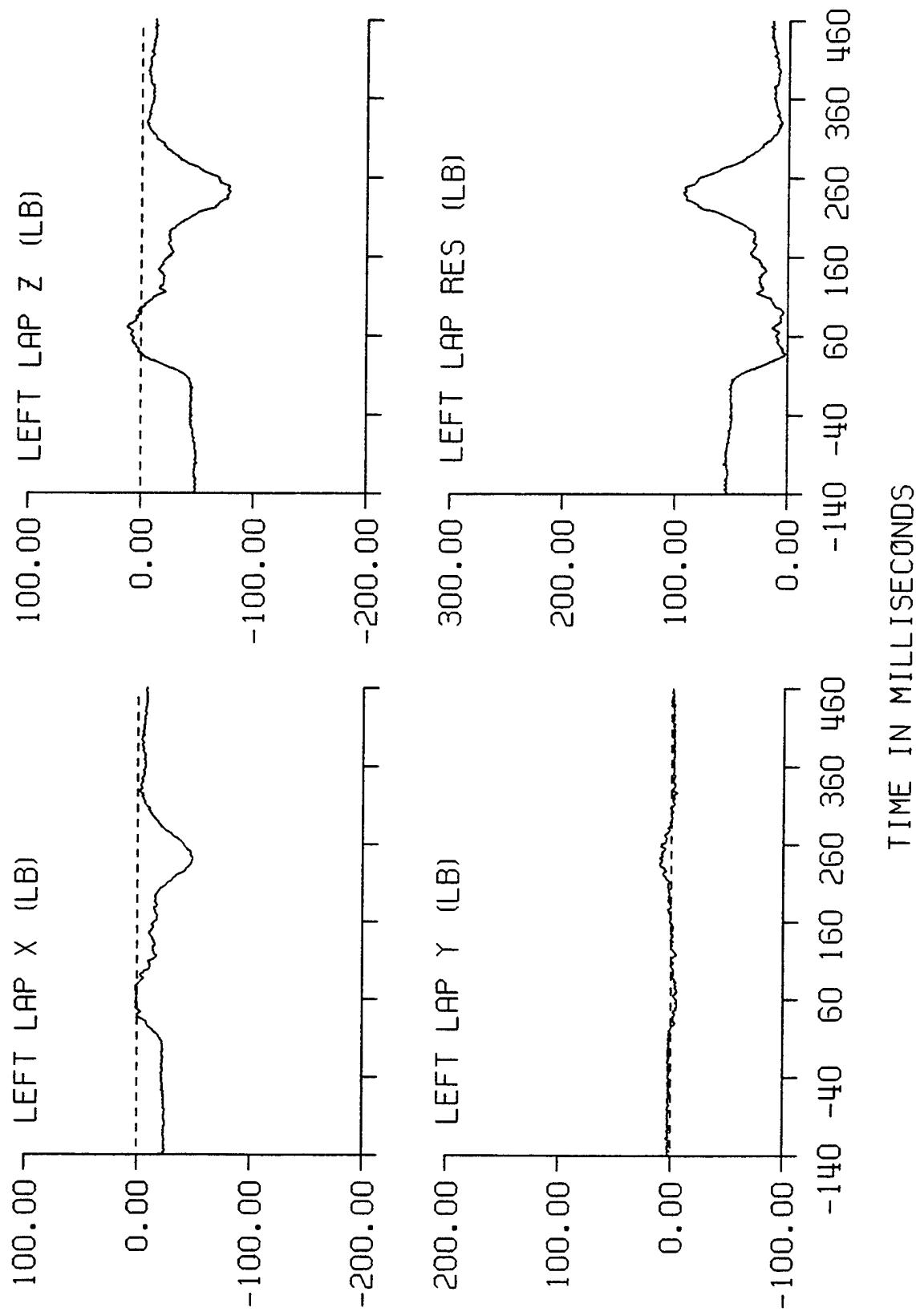
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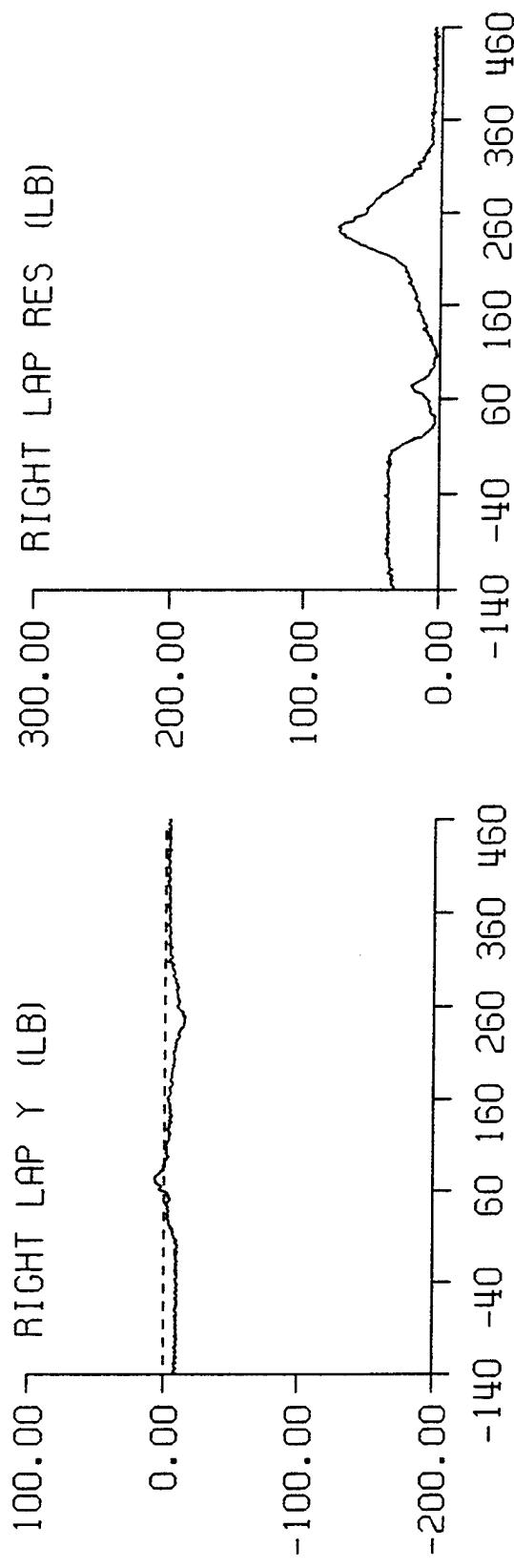
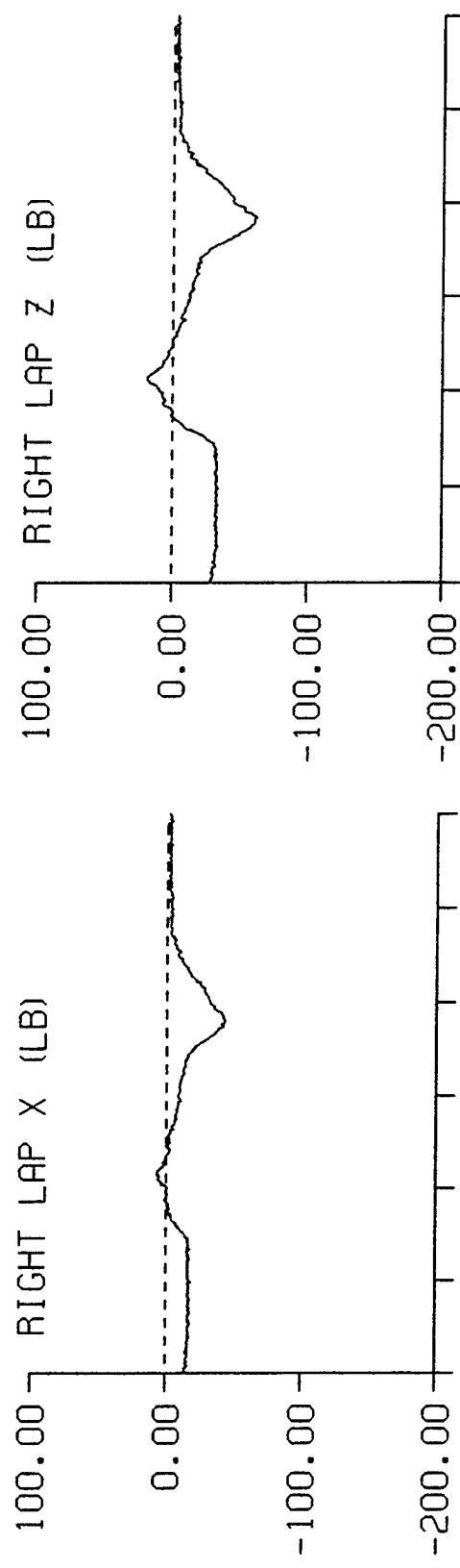
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122



JMB STUDY TEST: 3840 SUBJ: JPAT-L CELL: F

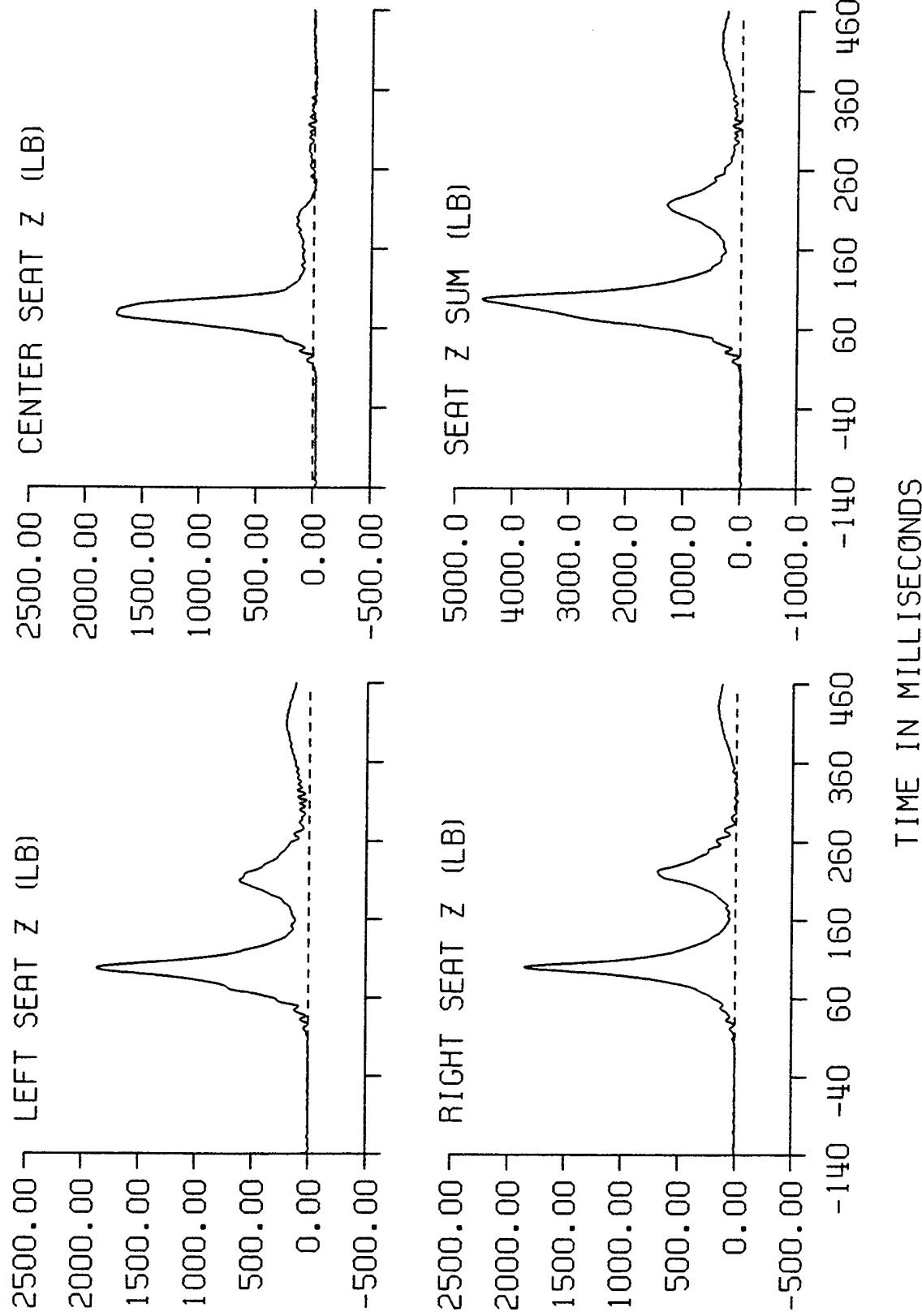


JMB STUDY TEST: 3840 SUBJ: JPAT-L CELL: F

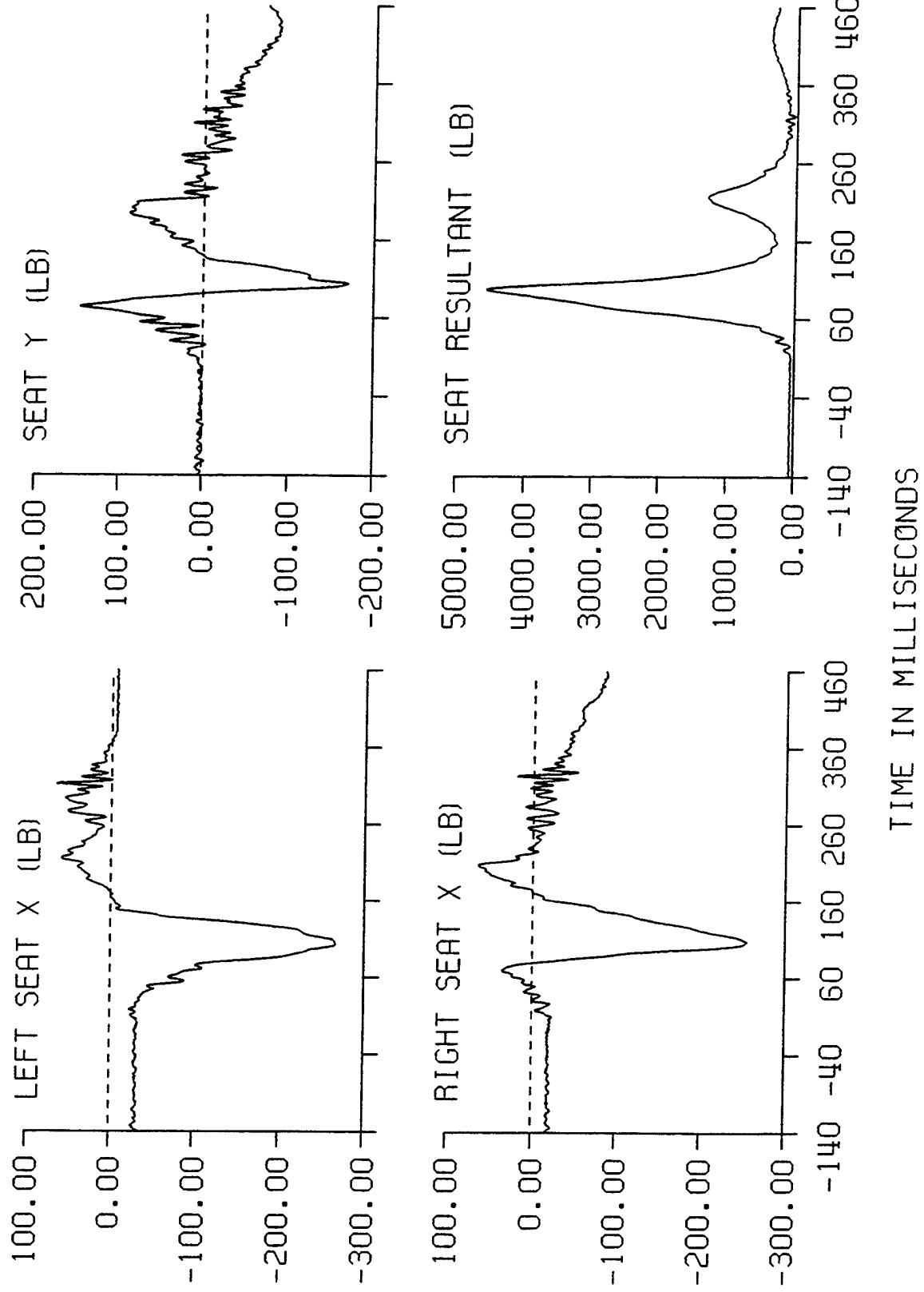


TIME IN MILLISECONDS

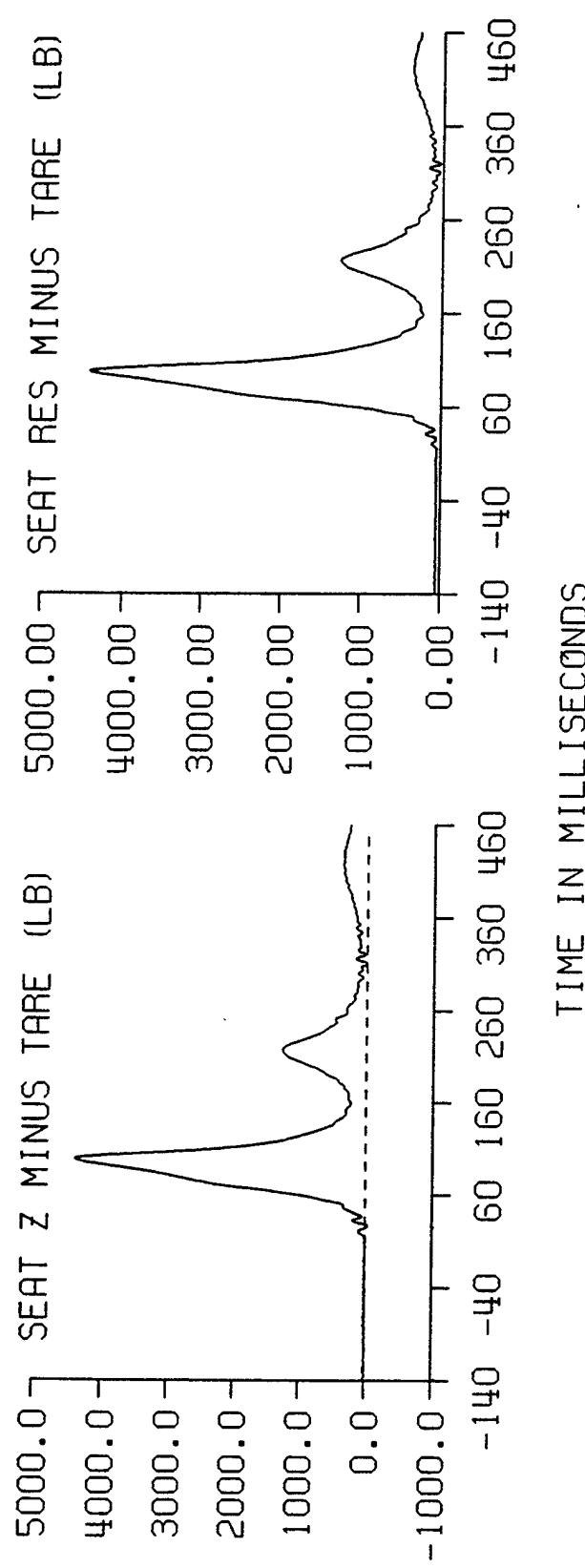
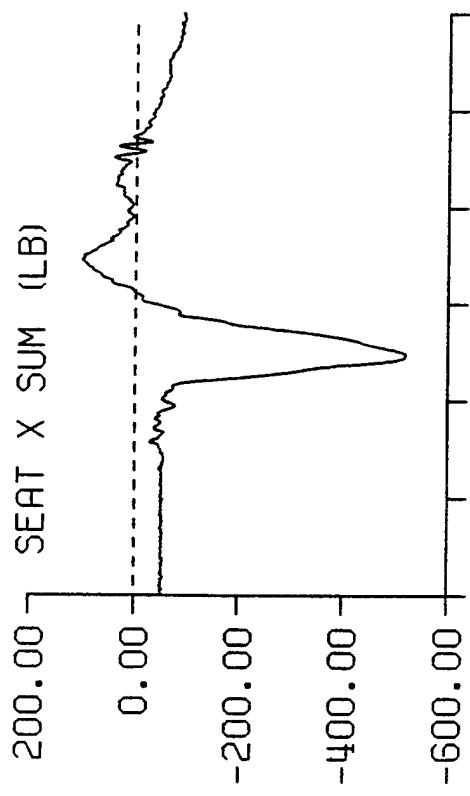
JMB STUDY TEST: 3840 SUBJ: JPAT-L CELL: F



JMB STUDY TEST: 3840 SUBJ: JPAT-L CELL: F



JMB STUDY TEST: 3840 SUBJ: JPAT-L CELL: F



JMB STUDY TEST: 3851 TEST DATE: 26-JUL-1997 SUBJ: JPAT-L WT: 269.0  
 NOM G: 10.0 CELL: G

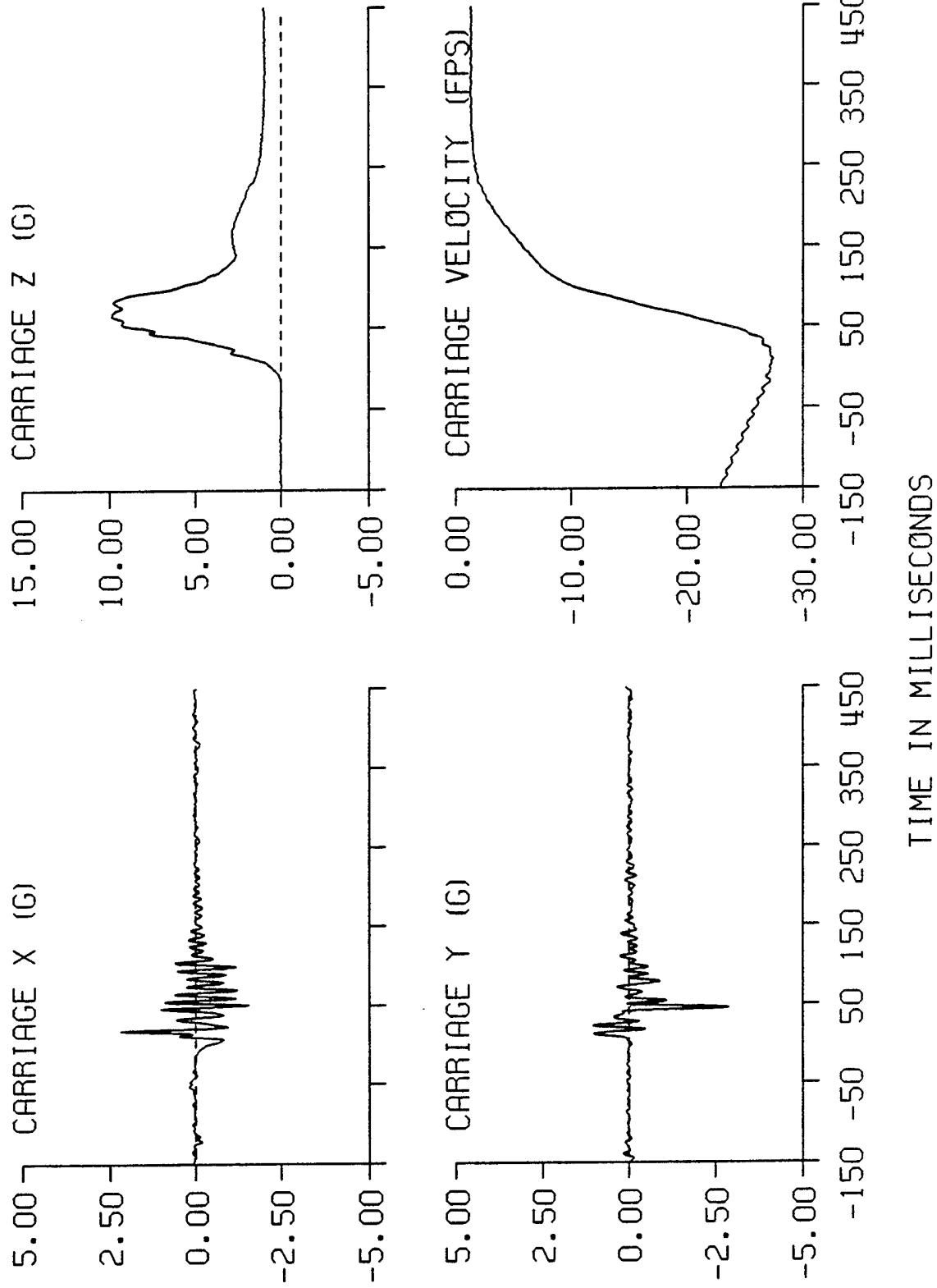
DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
REFERENCE MARK TIME (MS)				-159.	
CARRIAGE ACCELERATION (G)					
X AXIS	-0.01	2.18	-1.56	18.	51.
Y AXIS	0.02	1.05	-2.89	23.	45.
Z AXIS	0.03	9.83	0.48	65.	0.
CARRIAGE VELOCITY (FPS)	-26.92	-1.23	-27.44	339.	8.
SEAT ACCELERATION (G)					
X AXIS	-0.01	1.93	-1.24	18.	70.
Y AXIS	0.05	1.99	-3.49	64.	51.
Z AXIS	0.04	12.21	0.27	69.	5.
EXT CHEST ACCELERATION (G)					
X AXIS	0.02	9.98	-0.05	92.	326.
Y AXIS	-0.06	0.83	-1.63	101.	86.
Z AXIS	0.00	20.18	-0.89	85.	171.
RESULTANT	0.08	22.09	0.04	85.	2.
HEADREST FORCES (LB)					
UPPER X AXIS	-1.53	8.13	-11.22	358.	56.
LOWER X AXIS	-3.91	11.07	-4.73	356.	254.
X AXIS SUM	-5.44	19.20	-10.01	358.	20.
SHOULDER FORCES (LB)					
X AXIS	-8.03	0.44	-186.69	297.	98.
Y AXIS	-5.30	12.73	-13.31	81.	45.
Z AXIS	-12.70	91.49	-11.84	93.	0.
RESULTANT	16.01	206.28	4.17	98.	37.
LAP FORCES (LB)					
LEFT X AXIS	-20.63	2.54	-21.55	54.	0.
LEFT Y AXIS	3.13	5.55	-7.76	17.	52.
LEFT Z AXIS	-45.33	11.33	-45.81	68.	0.
LEFT RESULTANT	49.91	50.74	1.21	0.	38.
RIGHT X AXIS	-22.88	1.04	-23.50	54.	0.
RIGHT Y AXIS	-11.68	0.44	-12.02	63.	0.
RIGHT Z AXIS	-42.60	9.67	-41.96	55.	0.
RIGHT RESULTANT	49.75	49.57	2.05	0.	36.

JMB STUDY TEST: 3851 TEST DATE: 26-JUL-1997 SUBJ: JPAT-L WT: 269.0  
NOM G: 10.0 CELL: G

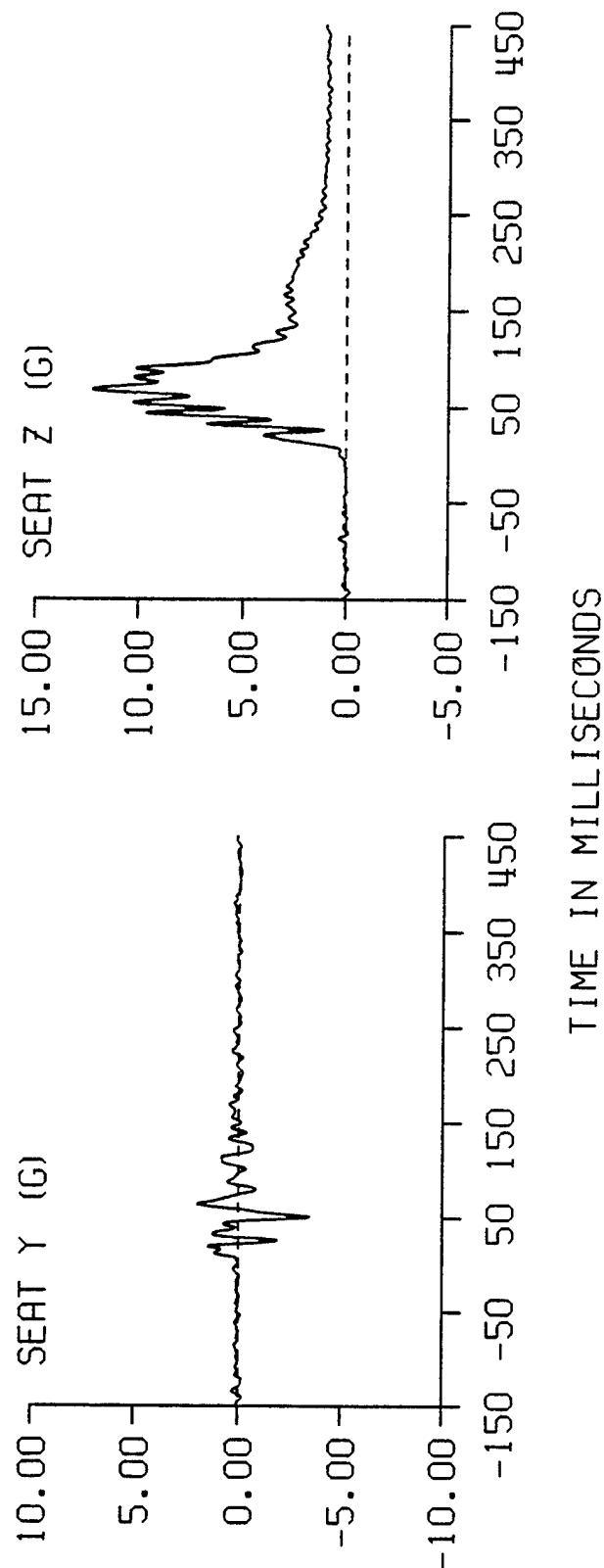
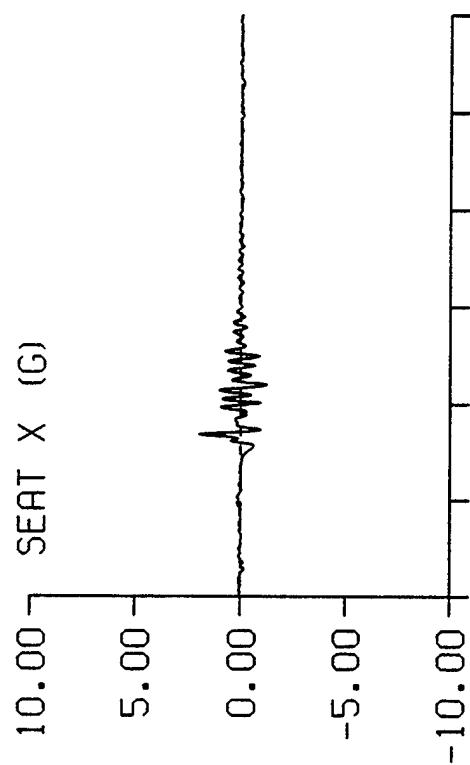
DATA ID	IMMEDIATE PREIMPACT	MAXIMUM VALUE	MINIMUM VALUE	TIME OF MAXIMUM	TIME OF MINIMUM
SEAT FORCES (LB)					
LEFT X AXIS	-34.98	-30.08	-540.40	319.	91.
RIGHT X AXIS	-13.06	40.91	-243.17	55.	116.
X AXIS SUM	-48.04	-20.58	-739.57	33.	91.
Y AXIS	16.86	123.44	-62.53	71.	106.
LEFT Z AXIS	19.22	2252.39	20.77	76.	0.
RIGHT Z AXIS	28.79	1793.36	33.11	70.	2.
CENTER Z AXIS	-25.30	859.68	-51.25	96.	37.
Z AXIS SUM	22.71	4167.61	31.44	73.	0.
RESULTANT	55.84	4184.36	60.83	73.	0.
Z SUM MINUS TARE	47.71	3948.06	33.26	73.	8.
RESULTANT MINUS TARE	69.83	3965.73	63.24	73.	12.

Page 2 of 2

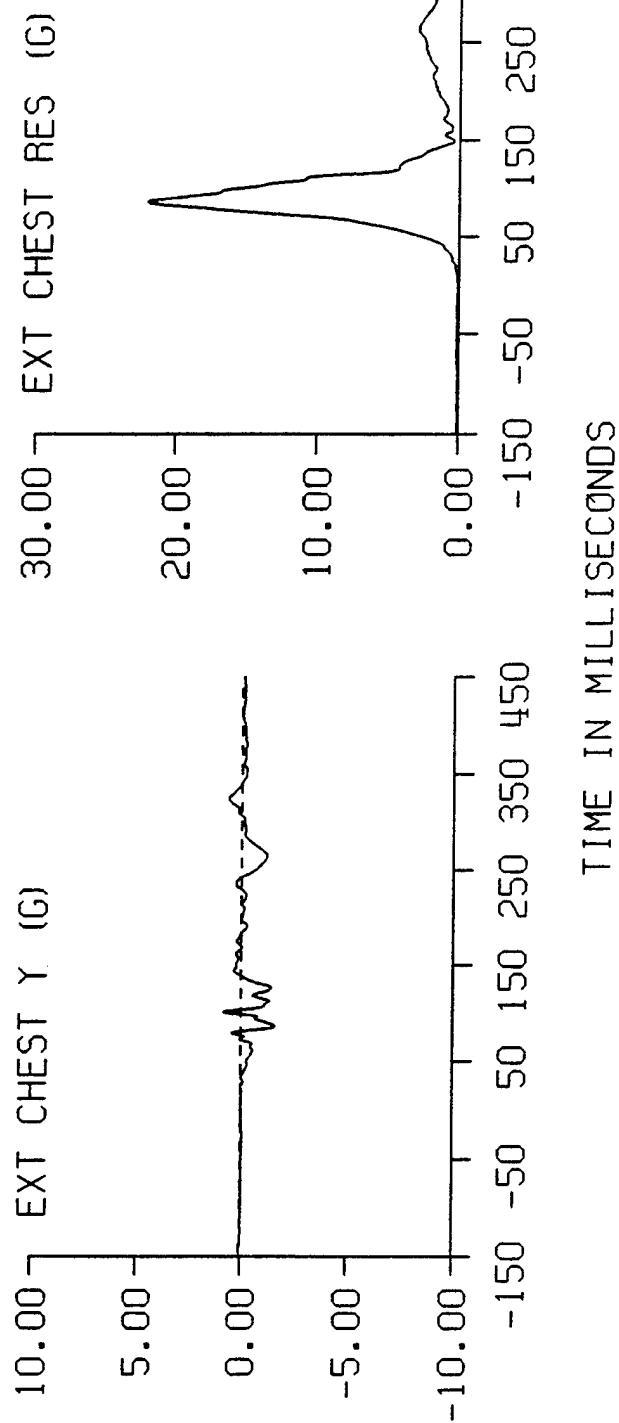
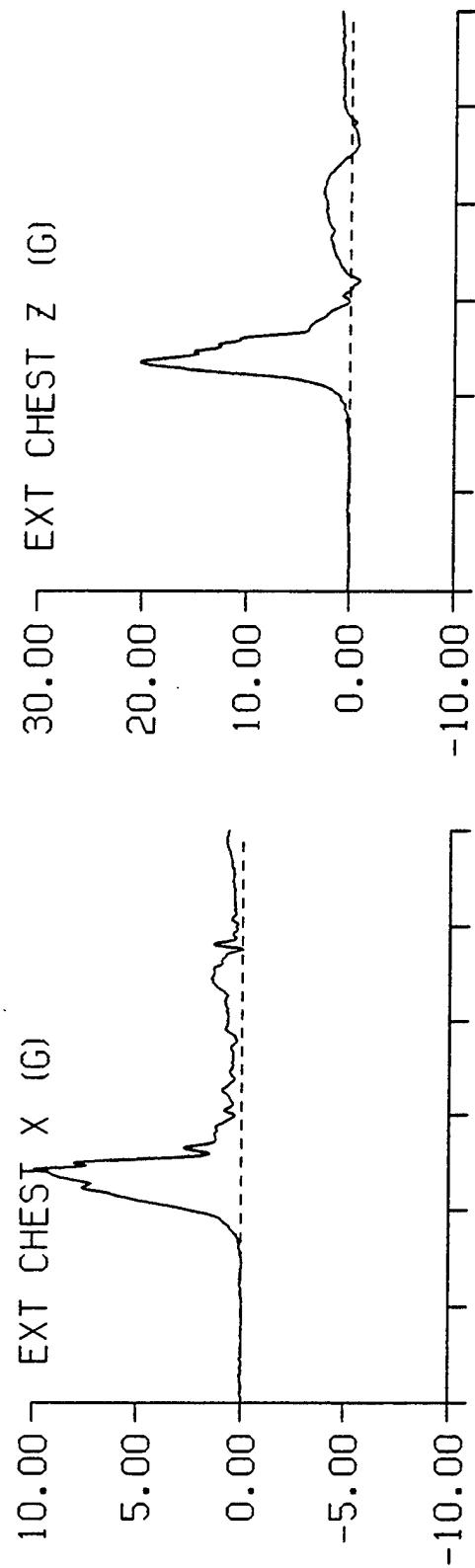
JMB STUDY TEST: 3851 SUBJ: JPAT-L CELL: G



JMB STUDY TEST: 3851 SUBJ: JPAT-L CELL: 6

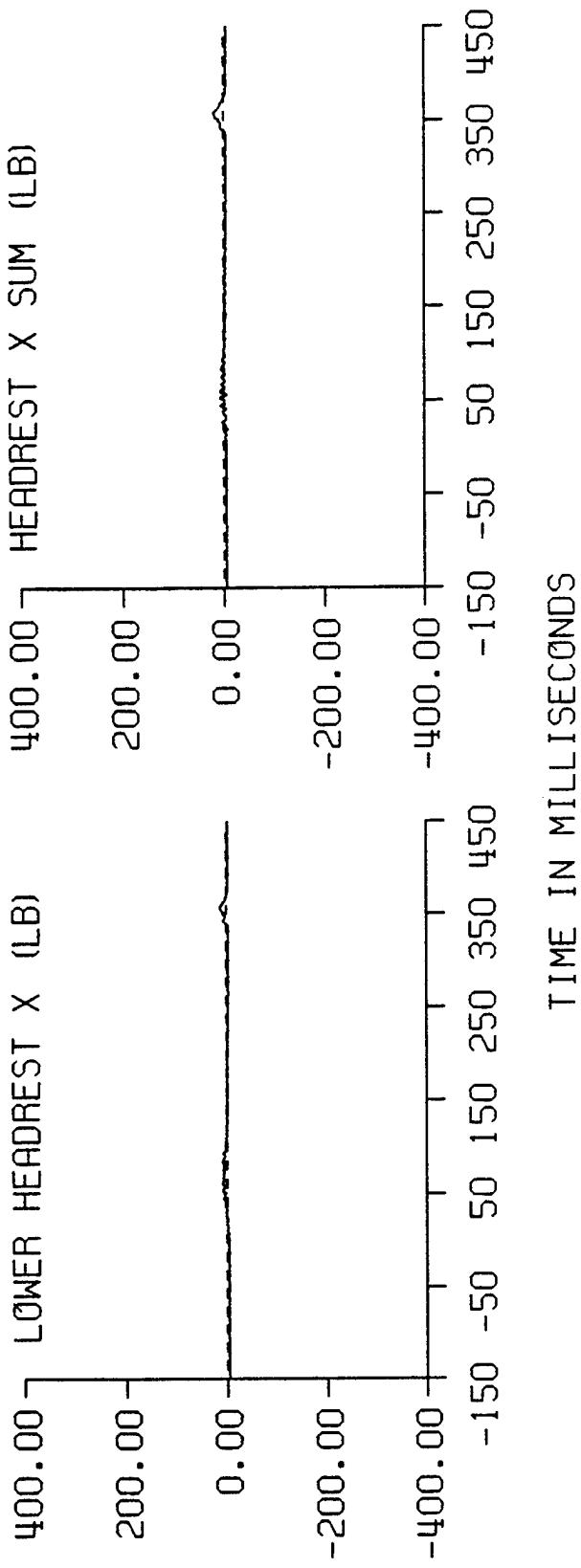
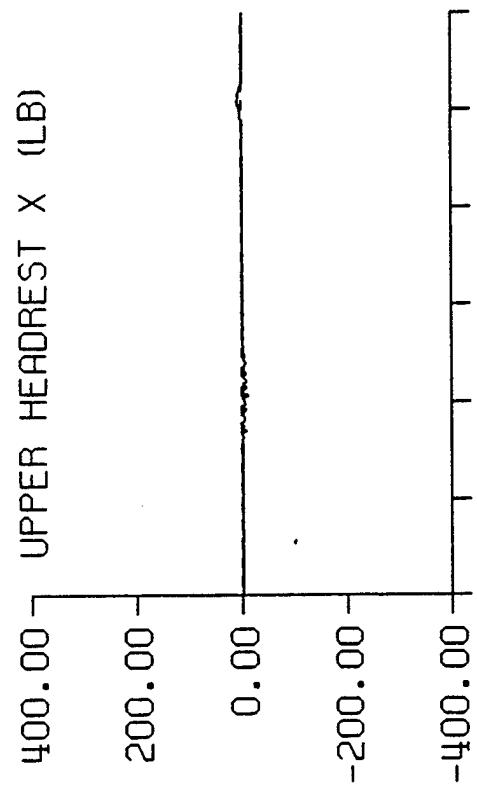


JMB STUDY TEST: 3851 SUBJ: JPAT-L CELL: 6

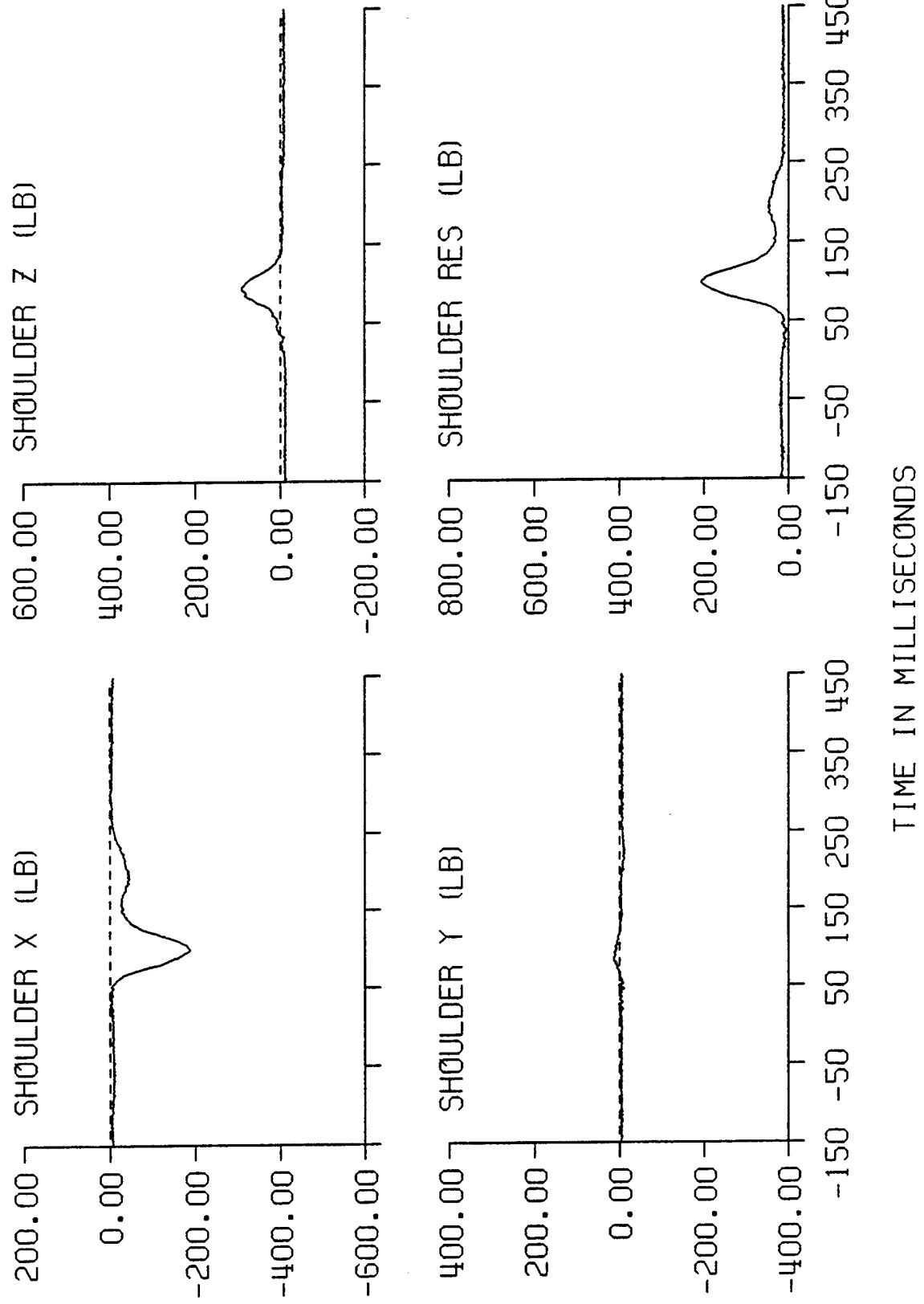


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 $^{132}$

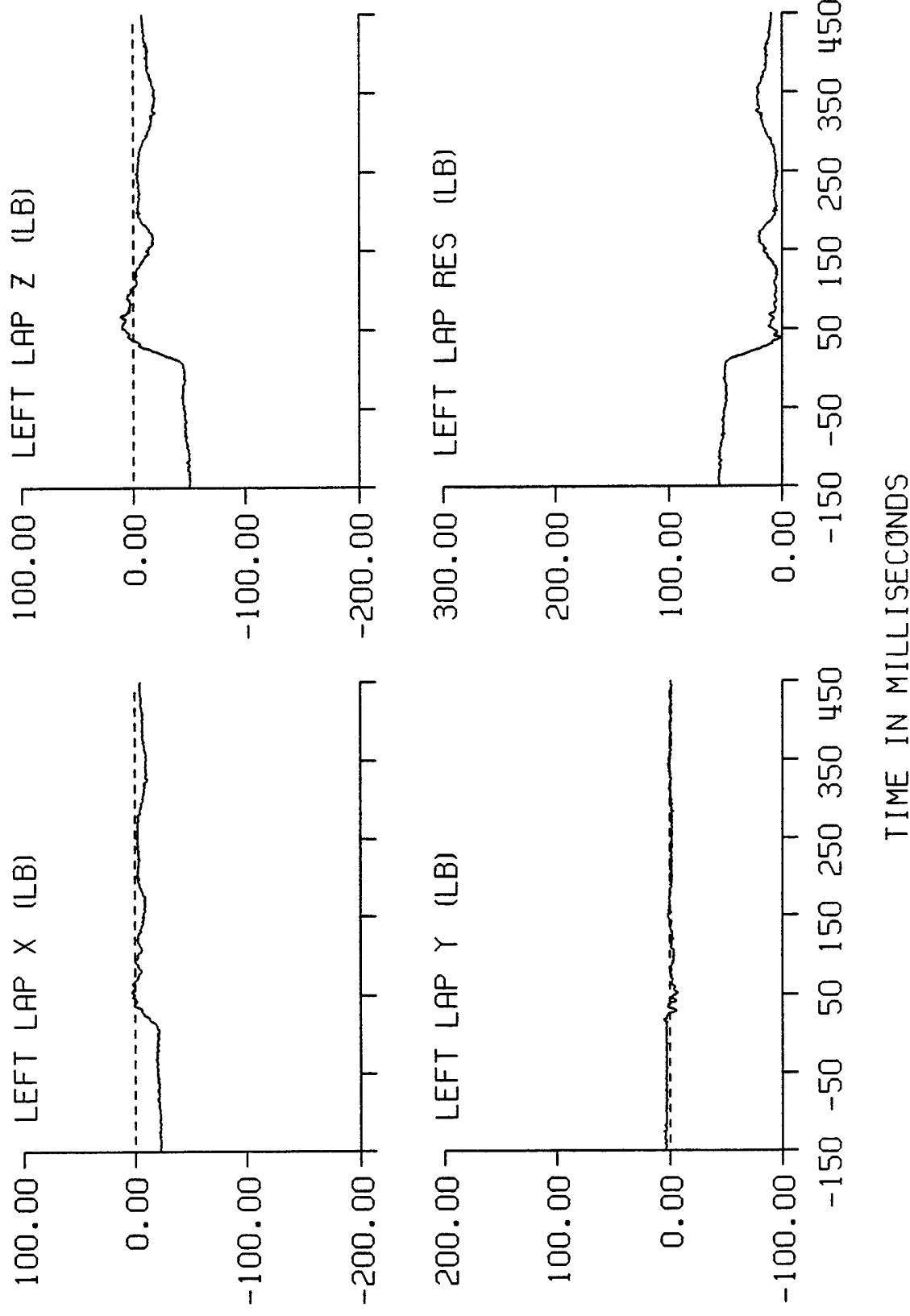
JMB STUDY TEST: 3851 SUBJ: JPAT-L CELL: G



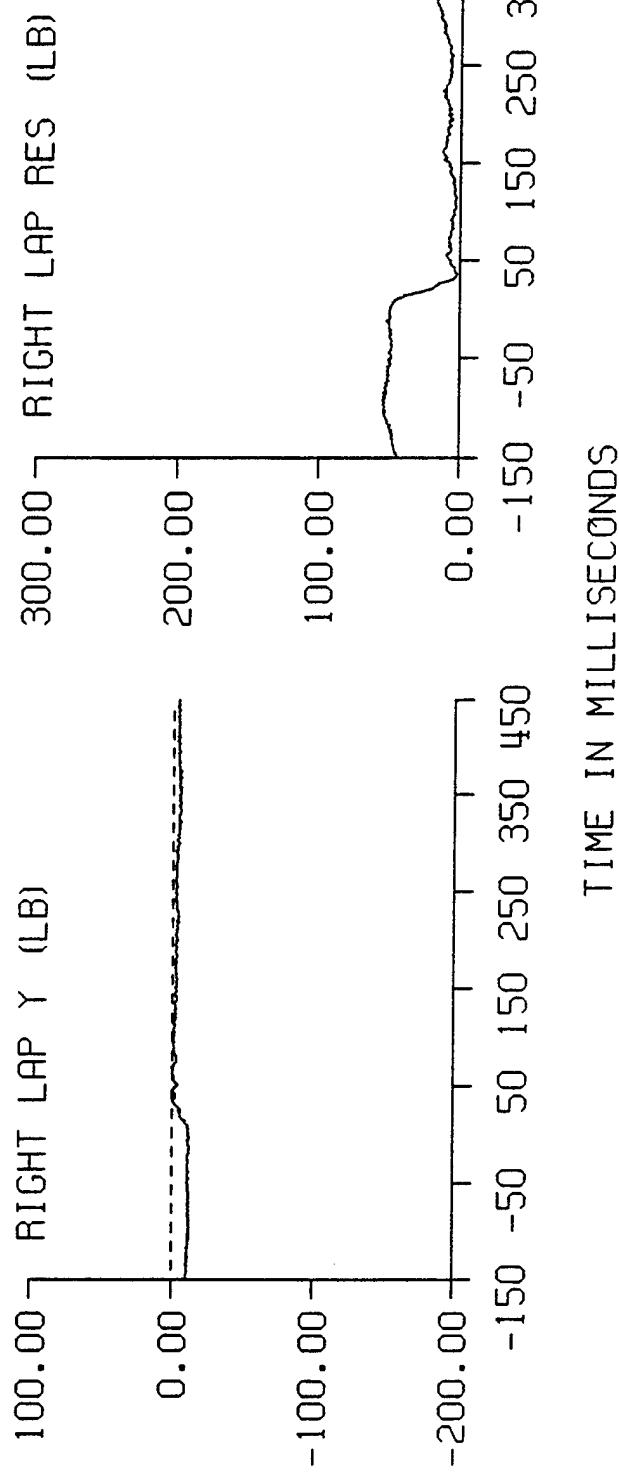
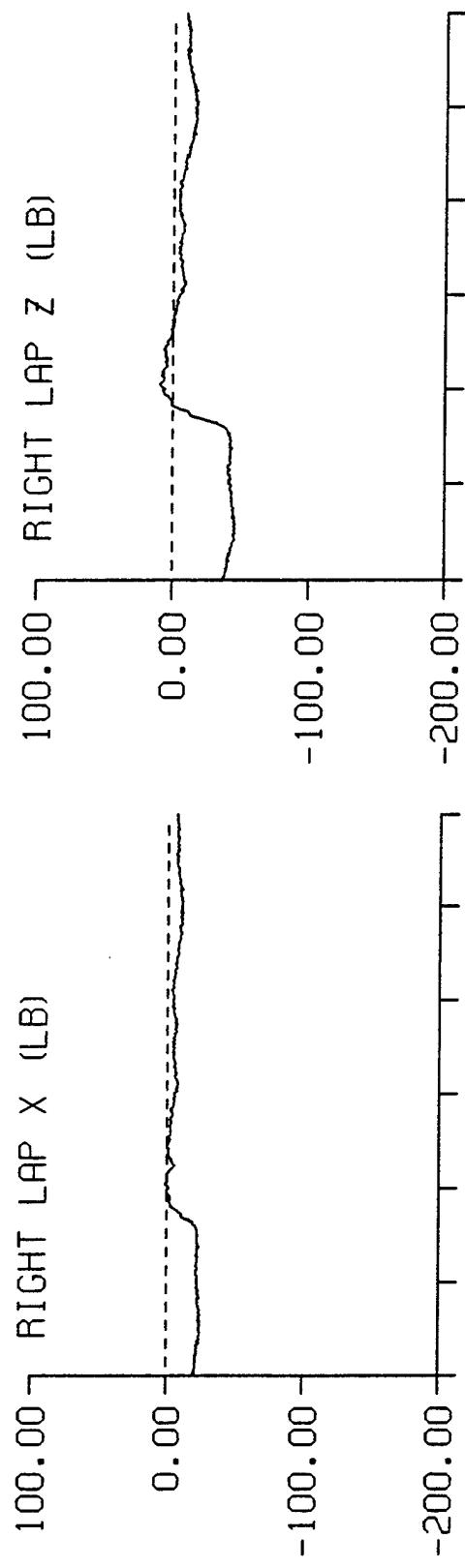
JMB STUDY TEST: 3851 SUBJ: JPAT-L CELL: 6



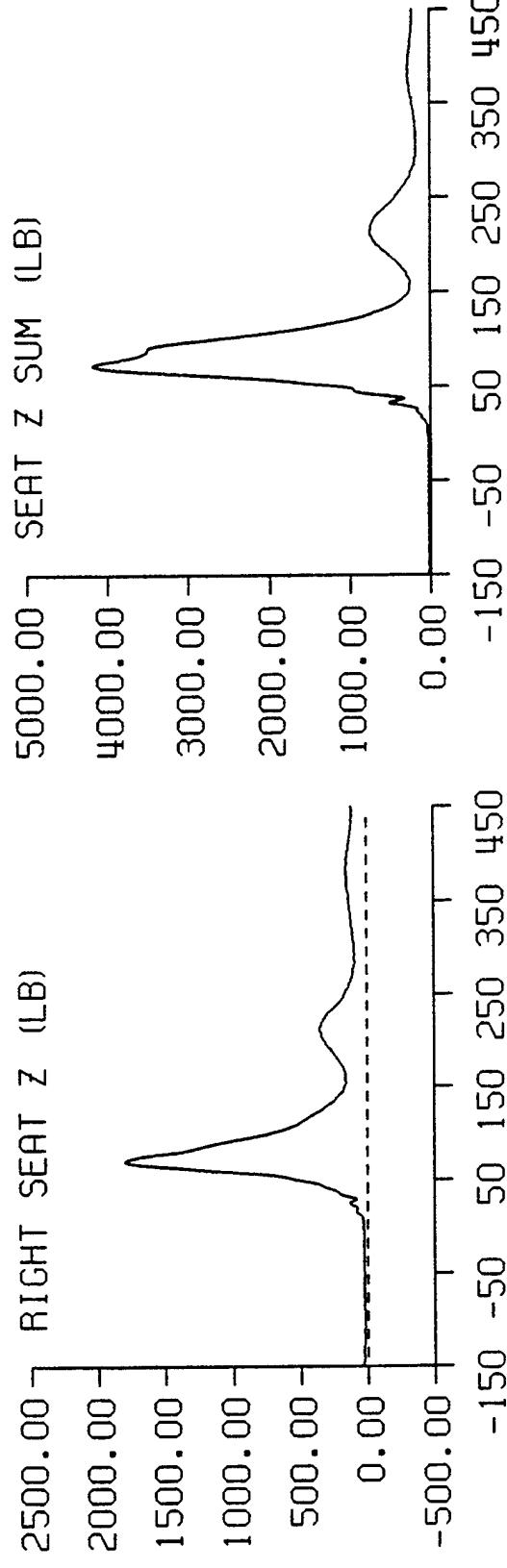
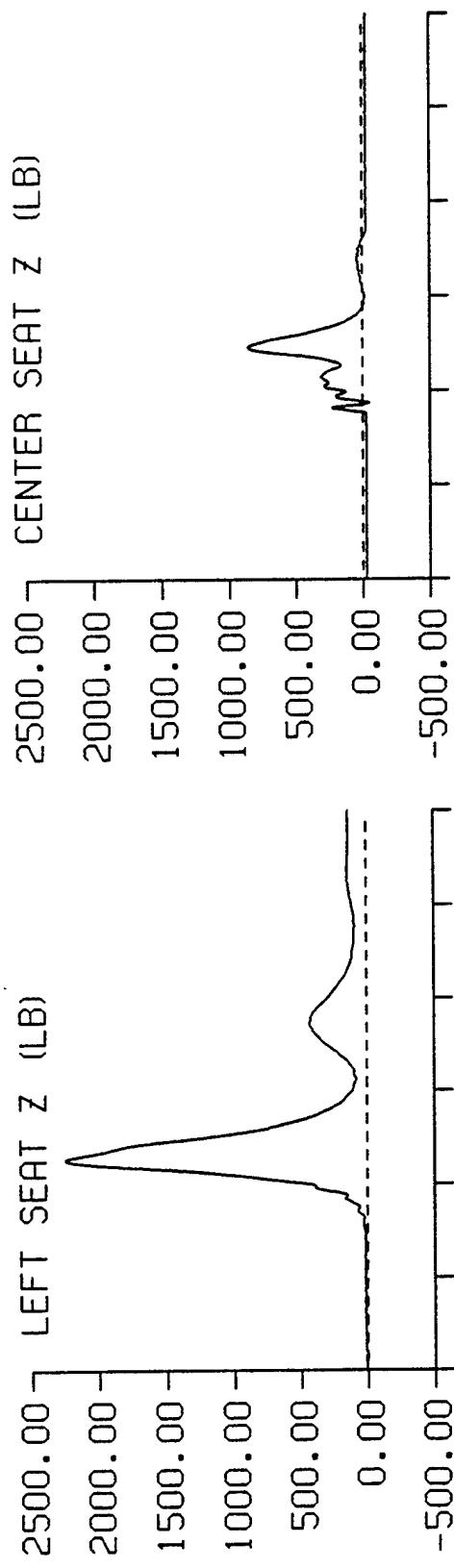
JMB STUDY TEST: 3851 SUBJ: JPAT-L CELL: 6



JMB STUDY TEST: 3851 SUBJ: JPAT-L CELL: G

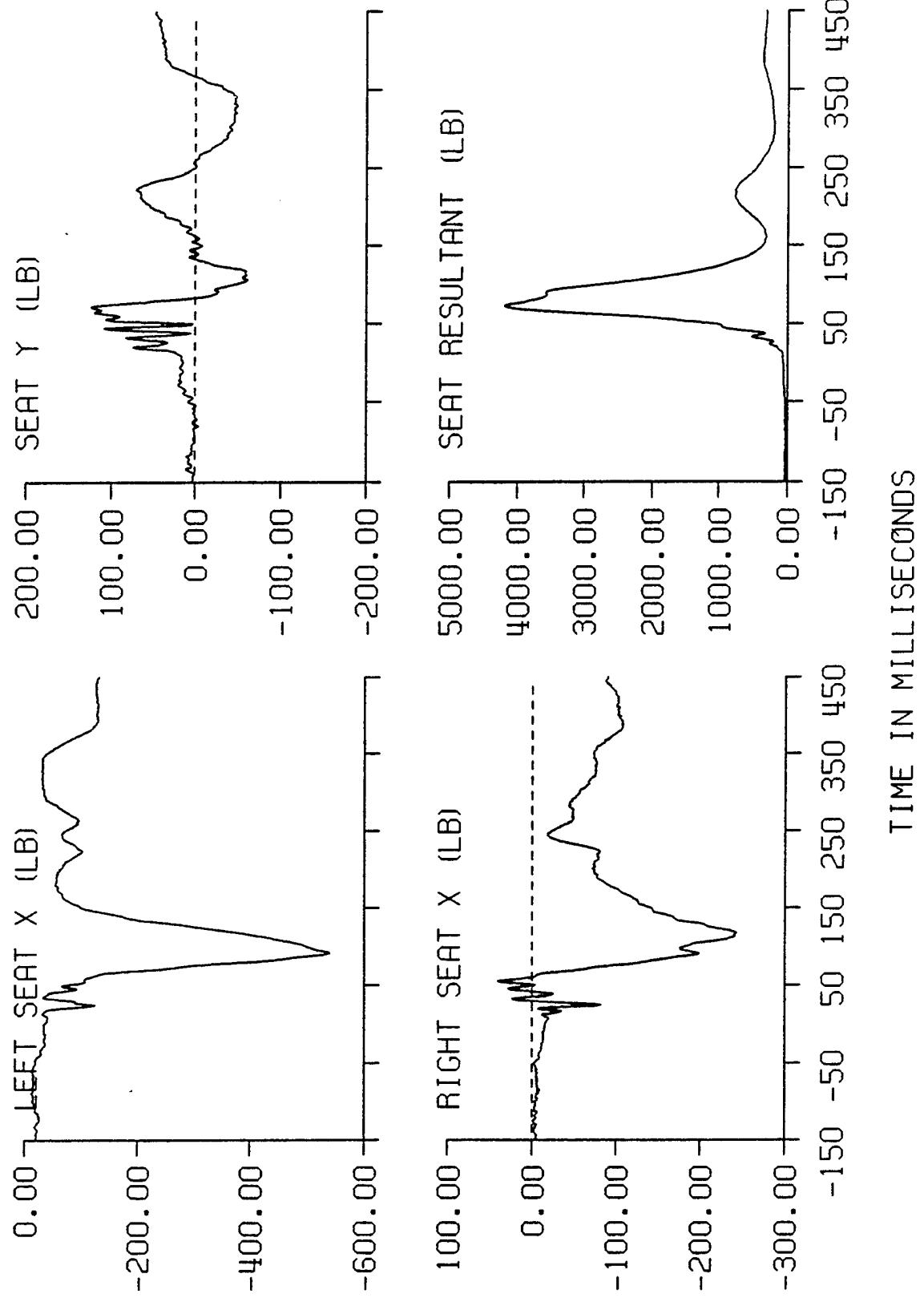


JMB STUDY TEST: 3851 SUBJ: JPAT-L CELL: G

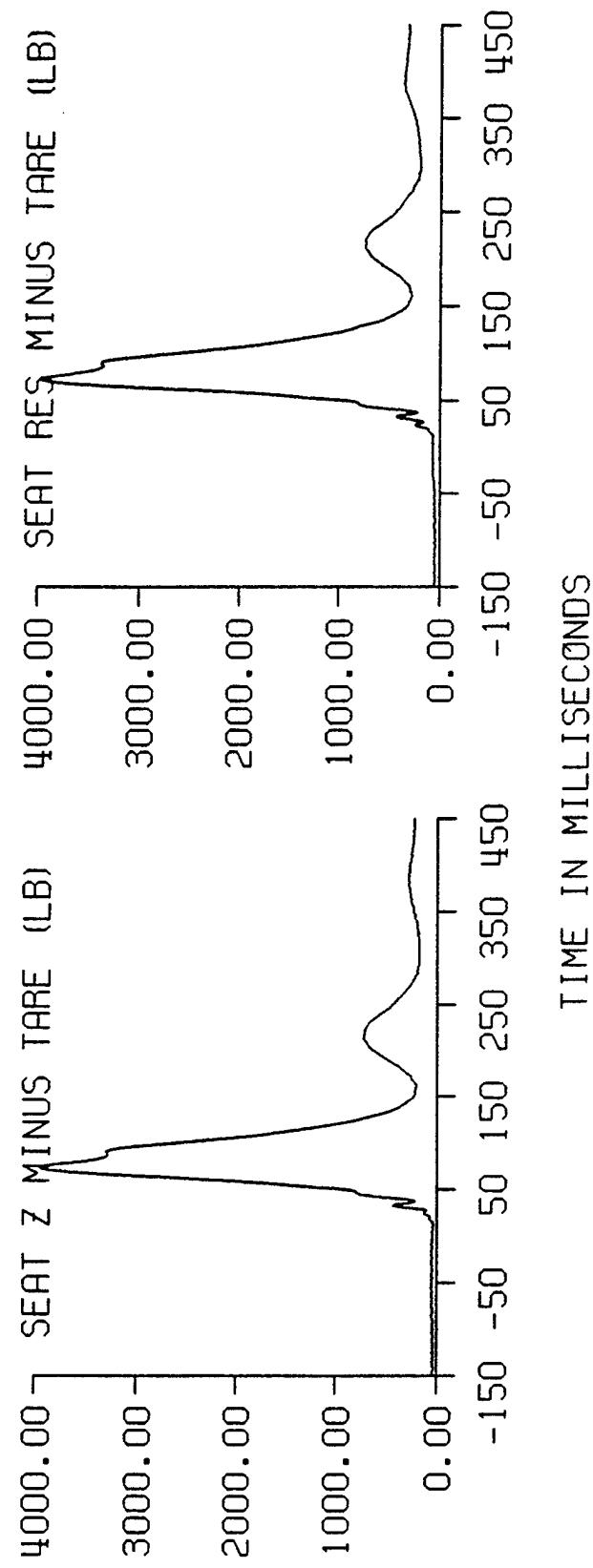
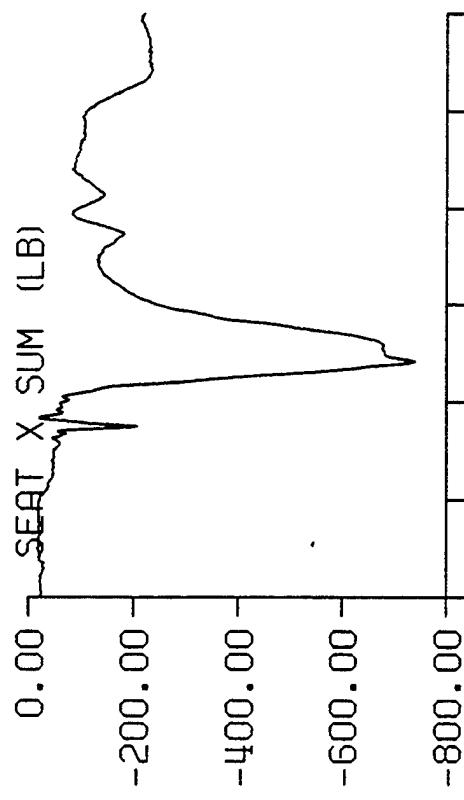


TIME IN MILLISECONDS

JMB STUDY TEST: 3851 SUBJ: JPAT-L CELL: 6



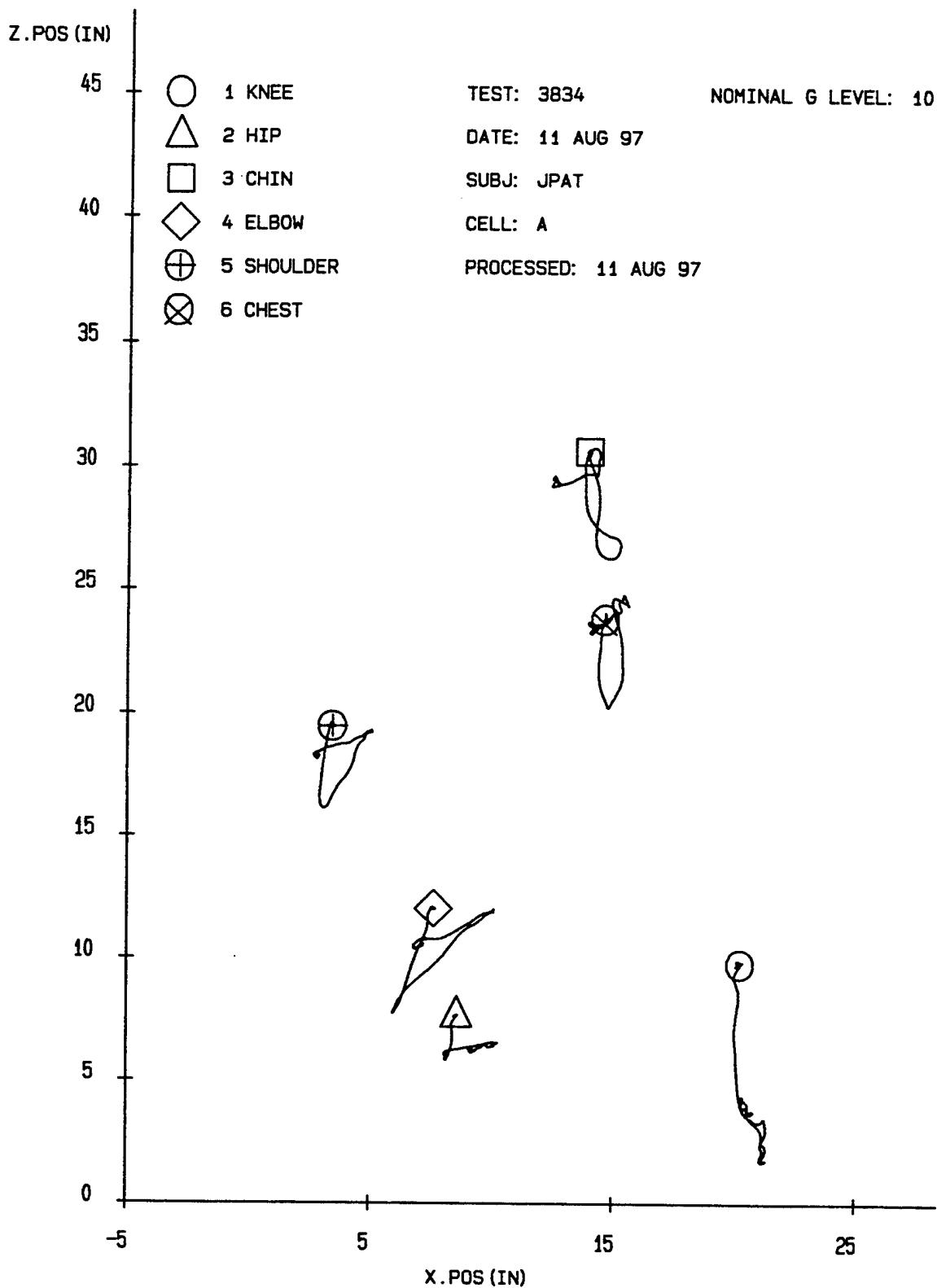
JMB STUDY TEST: 3851 SUBJ: JPAT-L CELL: 6



## **APPENDIX C**

### **SAMPLE SELSPOT DATA**

JMB STUDY



JMB STUDY  
TEST: 3834 DATE: 11 AUG 97 SUBJ: JPAT CELL: A

RELIABILITY FACTORS (IN)

TARGET DESCRIPTION	MAXIMUM	MINIMUM	AVERAGE	STANDARD DEVIATION	AT MAX DISPLACEMENT
1 KNEE	0.2408	0.0004	0.0957	0.0568	0.1107
2 HIP	0.1542	0.0004	0.0500	0.0394	0.0203
3 CHIN	0.2122	0.0095	0.1226	0.0464	0.0308
4 ELBOW	0.1878	0.0003	0.0389	0.0323	0.0511
5 SHOULDER	0.1496	0.0004	0.0598	0.0314	0.1496
6 CHEST	0.1844	0.0016	0.0603	0.0466	0.0805

PREIMPACT POSITION (IN)

TARGET DESCRIPTION	X	Y	Z
1 KNEE	20.1400	-16.3659	9.7445
2 HIP	8.5074	-12.7792	7.6256
3 CHIN	13.8772	-6.6466	30.6557
4 ELBOW	7.5627	-17.7382	12.0326
5 SHOULDER	3.4242	-14.1307	19.4903
6 CHEST	14.6330	-6.4147	23.8471

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
KNEE				
POSITION(IN)				
X AXIS	21.3653	0.1480	20.0071	0.0360
Y AXIS	-16.0948	0.0540	-18.1633	0.4060
Z AXIS	9.8623	0.0100	1.7136	0.1980
VELOCITY(IN/SEC)	131.3139	0.0760	4.2126	0.2060
ACCELERATION(G)	12.9782	0.0940	0.7273	0.4160
DISPLACEMENT(IN)				
X AXIS	1.2253	0.1480	-0.1329	0.0360
Y AXIS	0.2711	0.0540	-1.7974	0.4060
Z AXIS	0.1177	0.0100	-8.0309	0.1980
RESULTANT	8.2928	0.2000	0.0000	0.0000

JMB STUDY  
 TEST: 3834 DATE: 11 AUG 97 SUBJ: JPAT CELL: A

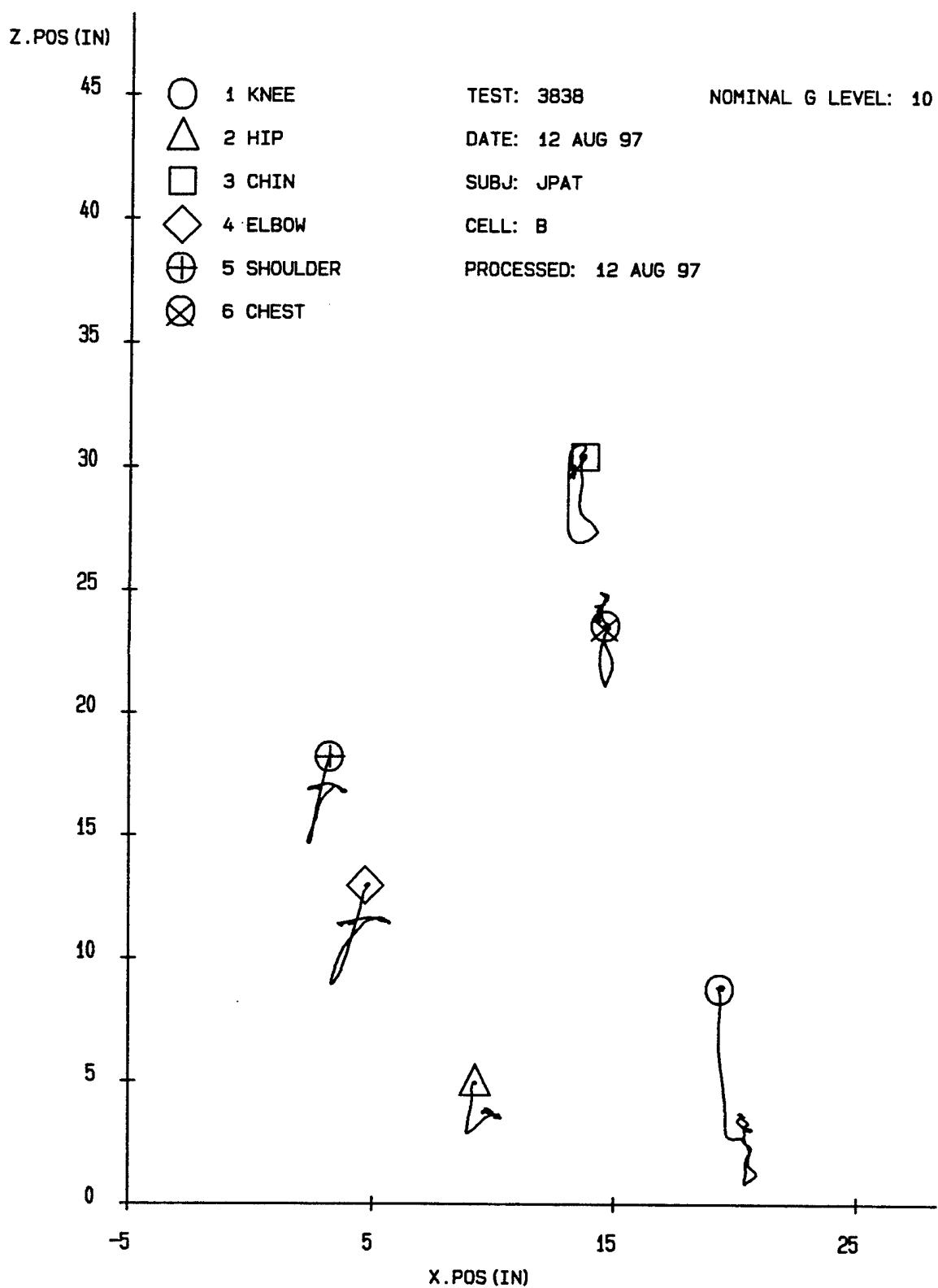
TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
HIP				
POSITION(IN)				
X AXIS	10.2965	0.2060	8.1105	0.1020
Y AXIS	-12.2373	0.0520	-14.1418	0.1300
Z AXIS	7.6503	0.0080	5.8374	0.0660
VELOCITY(IN/SEC)	120.6243	0.1400	3.6817	0.3420
ACCELERATION(G)	15.7496	0.1260	0.2442	0.3120
DISPLACEMENT(IN)				
X AXIS	1.7890	0.2060	-0.3970	0.1020
Y AXIS	0.5418	0.0520	-1.3626	0.1300
Z AXIS	0.0247	0.0080	-1.7881	0.0660
RESULTANT	2.1067	0.2060	0.0000	0.0000
CHIN				
POSITION(IN)				
X AXIS	15.2162	0.1120	12.3817	0.3440
Y AXIS	-6.0543	0.1740	-7.8951	0.3700
Z AXIS	30.7583	0.2000	26.2590	0.1280
VELOCITY(IN/SEC)	109.7450	0.1720	2.4884	0.4620
ACCELERATION(G)	14.6053	0.1900	0.3241	0.4300
DISPLACEMENT(IN)				
X AXIS	1.3391	0.1120	-1.4954	0.3440
Y AXIS	0.5923	0.1740	-1.2484	0.3700
Z AXIS	0.1026	0.2000	-4.3967	0.1280
RESULTANT	4.5315	0.1240	0.0000	0.0000
ELBOW				
POSITION(IN)				
X AXIS	10.1047	0.2080	5.9876	0.0900
Y AXIS	-16.4592	0.0880	-17.7427	0.0020
Z AXIS	12.0604	0.0080	7.7279	0.0900
VELOCITY(IN/SEC)	122.0314	0.0660	2.4052	0.3780

## JMB STUDY

TEST: 3834 DATE: 11 AUG 97 SUBJ: JPAT CELL: A

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
ELBOW				
ACCELERATION(G)	16.8626	0.0860	0.7680	0.4180
DISPLACEMENT(IN)				
X AXIS	2.5420	0.2080	-1.5751	0.0900
Y AXIS	1.2790	0.0880	-0.0045	0.0020
Z AXIS	0.0278	0.0080	-4.3047	0.0900
RESULTANT	4.7538	0.0900	0.0000	0.0000
SHOULDER				
POSITION(IN)				
X AXIS	5.0652	0.1920	2.6877	0.3400
Y AXIS	-13.4131	0.3860	-14.1558	0.0340
Z AXIS	19.5653	0.0120	16.1168	0.0880
VELOCITY(IN/SEC)	90.6390	0.0620	2.1103	0.3820
ACCELERATION(G)	12.0929	0.0820	0.1839	0.3980
DISPLACEMENT(IN)				
X AXIS	1.6410	0.1920	-0.7365	0.3400
Y AXIS	0.7176	0.3860	-0.0251	0.0340
Z AXIS	0.0750	0.0120	-3.3735	0.0880
RESULTANT	3.4017	0.0880	0.0000	0.0000
CHEST				
POSITION(IN)				
X AXIS	15.5695	0.1900	13.9000	0.3380
Y AXIS	-6.0694	0.1660	-7.4189	0.4600
Z AXIS	24.7608	0.2080	20.2067	0.0920
VELOCITY(IN/SEC)	94.2719	0.0600	3.9678	0.0080
ACCELERATION(G)	15.4834	0.0900	0.7450	0.4400
DISPLACEMENT(IN)				
X AXIS	0.9365	0.1900	-0.7330	0.3380
Y AXIS	0.3453	0.1660	-1.0041	0.4600
Z AXIS	0.9138	0.2080	-3.6404	0.0920
RESULTANT	3.7575	0.0920	0.0000	0.0000

JMB STUDY



JMB STUDY  
TEST: 3838 DATE: 12 AUG 97 SUBJ: JPAT CELL: B

RELIABILITY FACTORS (IN)

TARGET DESCRIPTION	MAXIMUM	MINIMUM	AVERAGE	STANDARD DEVIATION	AT MAX DISPLACEMENT
1 KNEE	0.2450	0.0287	0.1125	0.0455	0.0901
2 HIP	0.1066	0.0001	0.0373	0.0261	0.0456
3 CHIN	0.1432	0.0008	0.0721	0.0351	0.0274
4 ELBOW	0.0645	0.0002	0.0200	0.0146	0.0138
5 SHOULDER	0.1446	0.0002	0.0477	0.0333	0.0790
6 CHEST	0.5281	0.0004	0.1369	0.1370	0.0206

PREIMPACT POSITION (IN)

TARGET DESCRIPTION	X	Y	Z
1 KNEE	19.5092	-18.5019	8.8015
2 HIP	9.3228	-13.8446	4.9092
3 CHIN	13.6910	-7.8626	30.3226
4 ELBOW	4.8039	-16.8272	12.9337
5 SHOULDER	3.2237	-15.0016	18.2296
6 CHEST	14.7242	-7.4569	23.5738

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
KNEE				
POSITION(IN)				
X AXIS	20.9021	0.2320	19.3270	0.0600
Y AXIS	-18.2714	0.0260	-19.8746	0.1360
Z AXIS	8.8615	0.0080	0.8620	0.2020
VELOCITY(IN/SEC)	122.5996	0.0840	2.3341	0.3540
ACCELERATION(G)	13.3357	0.0980	0.5211	0.3940
DISPLACEMENT(IN)				
X AXIS	1.3929	0.2320	-0.1822	0.0600
Y AXIS	0.2306	0.0260	-1.3727	0.1360
Z AXIS	0.0600	0.0080	-7.9395	0.2020
RESULTANT	8.0745	0.2020	0.0000	0.0000

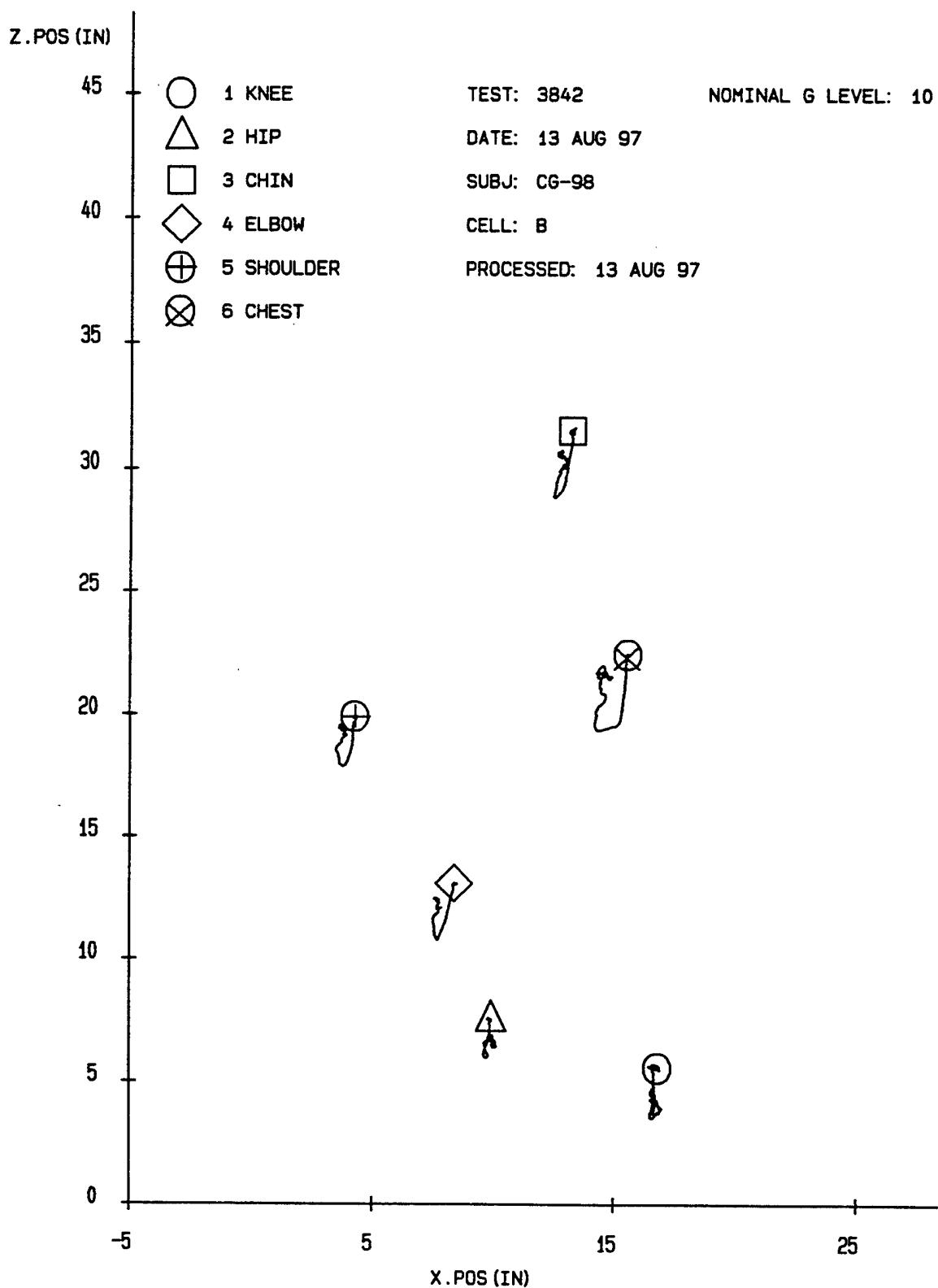
JMB STUDY  
 TEST: 3838 DATE: 12 AUG 97 SUBJ: JPAT CELL: B

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
HIP				
POSITION(IN)				
X AXIS	10.3534	0.2140	8.9336	0.0880
Y AXIS	-13.6092	0.4580	-14.3994	0.2020
Z AXIS	4.9415	0.0120	2.8918	0.0920
VELOCITY(IN/SEC)	51.8075	0.0540	1.8294	0.1460
ACCELERATION(G)	7.4732	0.0900	0.4034	0.4100
DISPLACEMENT(IN)				
X AXIS	1.0306	0.2140	-0.3892	0.0880
Y AXIS	0.2354	0.4580	-0.5548	0.2020
Z AXIS	0.0323	0.0120	-2.0174	0.0920
RESULTANT	2.0795	0.0920	0.0000	0.0000
CHIN				
POSITION(IN)				
X AXIS	14.2175	0.1080	13.0126	0.1580
Y AXIS	-7.7235	0.0240	-9.3941	0.1940
Z AXIS	30.9255	0.2040	26.9482	0.1360
VELOCITY(IN/SEC)	103.5667	0.1680	1.1103	0.3580
ACCELERATION(G)	12.8115	0.1460	0.1765	0.3780
DISPLACEMENT(IN)				
X AXIS	0.5266	0.1080	-0.6784	0.1580
Y AXIS	0.1391	0.0240	-1.5315	0.1940
Z AXIS	0.6029	0.2040	-3.3744	0.1360
RESULTANT	3.5996	0.1340	0.0000	0.0000
ELBOW				
POSITION(IN)				
X AXIS	5.7054	0.2080	3.2732	0.0960
Y AXIS	-15.6280	0.0940	-17.0001	0.0300
Z AXIS	12.9577	0.0060	8.9391	0.0920
VELOCITY(IN/SEC)	97.3528	0.0640	1.5600	0.2080

JMB STUDY  
TEST: 3838 DATE: 12 AUG 97 SUBJ: JPAT CELL: B

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
ELBOW				
ACCELERATION(G)	15.6475	0.0920	0.2926	0.4280
DISPLACEMENT(IN)				
X AXIS	0.9015	0.2080	-1.5307	0.0960
Y AXIS	1.1992	0.0940	-0.1729	0.0300
Z AXIS	0.0240	0.0060	-3.9946	0.0920
RESULTANT	4.4327	0.0920	0.0000	0.0000
SHOULDER				
POSITION(IN)				
X AXIS	3.8799	0.2140	2.2916	0.0980
Y AXIS	-14.4563	0.0900	-15.5731	0.2480
Z AXIS	18.2435	0.0060	14.6482	0.0900
VELOCITY(IN/SEC)	88.5411	0.0660	0.3075	0.4100
ACCELERATION(G)	13.2159	0.0880	0.2002	0.3700
DISPLACEMENT(IN)				
X AXIS	0.6563	0.2140	-0.9321	0.0980
Y AXIS	0.5453	0.0900	-0.5715	0.2480
Z AXIS	0.0138	0.0060	-3.5815	0.0900
RESULTANT	3.7306	0.0920	0.0000	0.0000
CHEST				
POSITION(IN)				
X AXIS	14.8865	0.1120	14.1821	0.3000
Y AXIS	-7.4152	0.0620	-9.3216	0.1640
Z AXIS	24.9008	0.2060	21.1054	0.0900
VELOCITY(IN/SEC)	73.7448	0.0660	0.9336	0.3800
ACCELERATION(G)	11.8400	0.1620	0.2718	0.4540
DISPLACEMENT(IN)				
X AXIS	0.1624	0.1120	-0.5421	0.3000
Y AXIS	0.0417	0.0620	-1.8647	0.1640
Z AXIS	1.3270	0.2060	-2.4684	0.0900
RESULTANT	2.4844	0.0900	0.0000	0.0000

JMB STUDY



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## JMB STUDY

TEST: 3842 DATE: 13 AUG 97 SUBJ: CG-98 CELL: B

## RELIABILITY FACTORS (IN)

TARGET DESCRIPTION	MAXIMUM	MINIMUM	AVERAGE	STANDARD DEVIATION	AT MAX DISPLACEMENT
1 KNEE	0.2573	0.0004	0.0840	0.0513	0.0806
2 HIP	0.1638	0.0001	0.0713	0.0345	0.0491
3 CHIN	0.1852	0.0018	0.0819	0.0393	0.0589
4 ELBOW	0.0823	0.0002	0.0312	0.0203	0.0603
5 SHOULDER	0.0977	0.0002	0.0371	0.0238	0.0600
6 CHEST	0.4088	0.0005	0.1342	0.1095	0.0622

## PREIMPACT POSITION (IN)

TARGET DESCRIPTION	X	Y	Z
1 KNEE	16.7319	-17.3839	5.6079
2 HIP	9.8915	-13.7535	7.5267
3 CHIN	13.2214	-8.0128	31.5004
4 ELBOW	8.3497	-16.3826	13.0349
5 SHOULDER	4.2465	-15.1207	19.8822
6 CHEST	15.5764	-8.2713	22.4038

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
KNEE				
POSITION(IN)				
X AXIS	16.9632	0.0820	16.4843	0.1960
Y AXIS	-17.1105	0.0840	-18.0247	0.1940
Z AXIS	5.6079	0.0000	3.5416	0.2060
VELOCITY(IN/SEC)	58.4683	0.0480	4.8082	0.3660
ACCELERATION(G)	9.3025	0.0620	0.2824	0.3320
DISPLACEMENT(IN)				
X AXIS	0.2313	0.0820	-0.2476	0.1960
Y AXIS	0.2734	0.0840	-0.6408	0.1940
Z AXIS	0.0000	0.0000	-2.0663	0.2060
RESULTANT	2.1342	0.2040	0.0000	0.0000

JMB STUDY  
 TEST: 3842 DATE: 13 AUG 97 SUBJ: CG-98 CELL: B

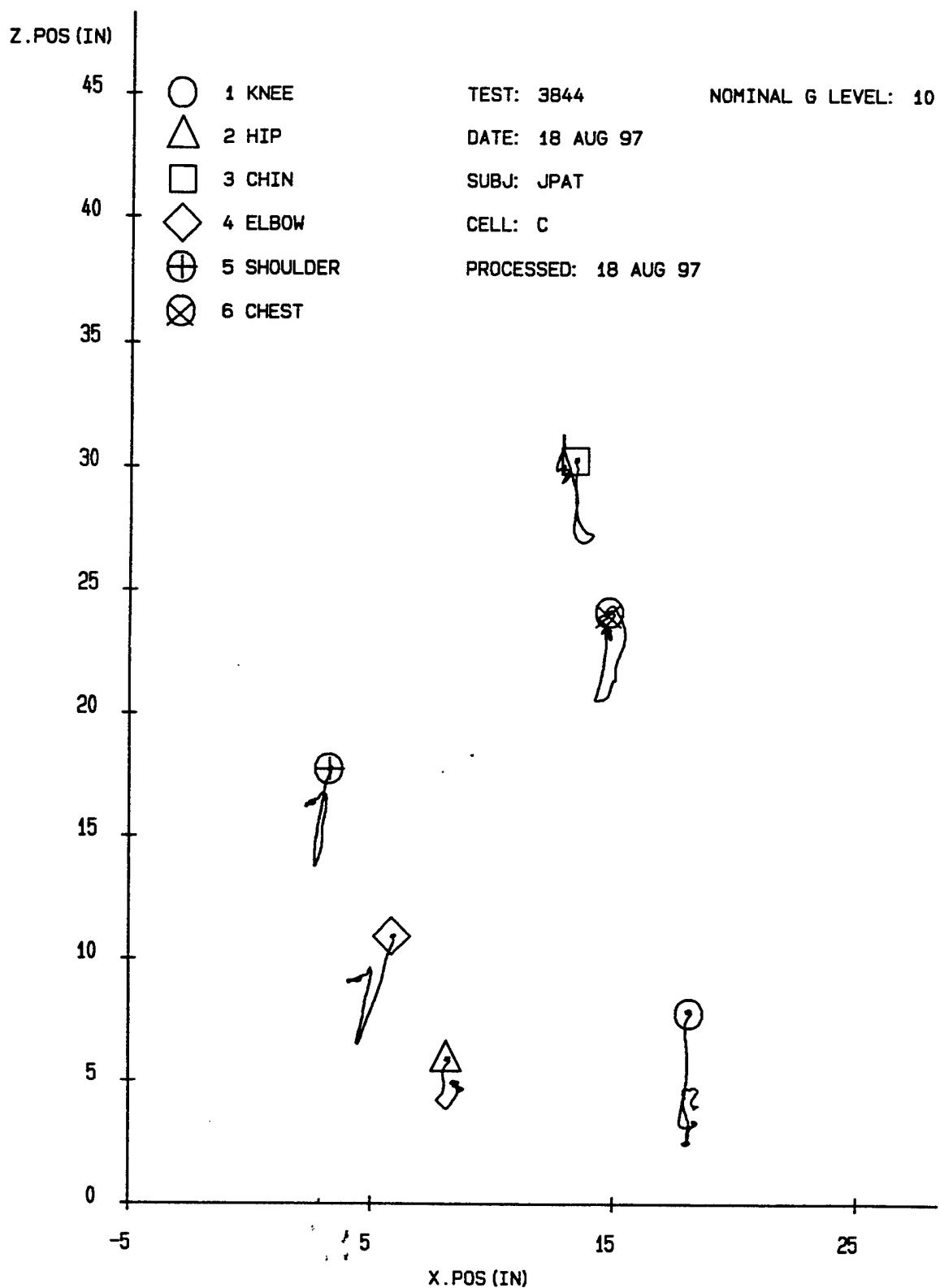
TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
HIP				
POSITION(IN)				
X AXIS	10.1272	0.2160	9.6158	0.0620
Y AXIS	-13.6142	0.0360	-14.2090	0.1480
Z AXIS	7.5287	0.0040	5.9931	0.0720
VELOCITY(IN/SEC)	56.1551	0.0480	2.0812	0.3280
ACCELERATION(G)	8.1245	0.0600	0.2060	0.2560
DISPLACEMENT(IN)				
X AXIS	0.2358	0.2160	-0.2757	0.0620
Y AXIS	0.1393	0.0360	-0.4555	0.1480
Z AXIS	0.0020	0.0040	-1.5335	0.0720
RESULTANT	1.5501	0.0700	0.0000	0.0000
CHIN				
POSITION(IN)				
X AXIS	13.2249	0.0040	12.4325	0.0960
Y AXIS	-7.5248	0.3120	-8.3134	0.0520
Z AXIS	31.5515	0.0100	28.8558	0.0920
VELOCITY(IN/SEC)	57.8901	0.0480	1.3692	0.2140
ACCELERATION(G)	9.3693	0.0960	0.5006	0.1360
DISPLACEMENT(IN)				
X AXIS	0.0036	0.0040	-0.7889	0.0960
Y AXIS	0.4880	0.3120	-0.3006	0.0520
Z AXIS	0.0511	0.0100	-2.6447	0.0920
RESULTANT	2.7569	0.0920	0.0000	0.0000
ELBOW				
POSITION(IN)				
X AXIS	8.3497	0.0000	7.4585	0.1160
Y AXIS	-15.6970	0.0840	-16.5529	0.0180
Z AXIS	13.0402	0.0060	10.7764	0.0760
VELOCITY(IN/SEC)	65.4976	0.0520	2.0466	0.3800

## JMB STUDY

TEST: 3842 DATE: 13 AUG 97 SUBJ: CG-98 CELL: B

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
ELBOW				
ACCELERATION(G)	9.1333	0.0760	0.2038	0.1940
DISPLACEMENT(IN)				
X AXIS	0.0000	0.0000	-0.8912	0.1160
Y AXIS	0.6856	0.0840	-0.1703	0.0180
Z AXIS	0.0053	0.0060	-2.2585	0.0760
RESULTANT	2.4446	0.0800	0.0000	0.0000
SHOULDER				
POSITION(IN)				
X AXIS	4.2922	0.0160	3.4705	0.1160
Y AXIS	-14.6409	0.3240	-15.1818	0.0500
Z AXIS	19.9029	0.0060	17.8782	0.0780
VELOCITY(IN/SEC)	54.8614	0.0500	0.9226	0.3800
ACCELERATION(G)	7.0397	0.0680	0.2377	0.3940
DISPLACEMENT(IN)				
X AXIS	0.0457	0.0160	-0.7760	0.1160
Y AXIS	0.4798	0.3240	-0.0612	0.0500
Z AXIS	0.0207	0.0060	-2.0041	0.0780
RESULTANT	2.0837	0.0800	0.0000	0.0000
CHEST				
POSITION(IN)				
X AXIS	15.5764	0.0000	14.1629	0.1040
Y AXIS	-8.2594	0.0360	-9.3830	0.4360
Z AXIS	22.4038	0.0000	19.3560	0.0940
VELOCITY(IN/SEC)	80.9187	0.0560	4.1928	0.3620
ACCELERATION(G)	9.5340	0.1580	0.5282	0.2140
DISPLACEMENT(IN)				
X AXIS	0.0000	0.0000	-1.4135	0.1040
Y AXIS	0.0119	0.0360	-1.1116	0.4360
Z AXIS	0.0000	0.0000	-3.0478	0.0940
RESULTANT	3.3518	0.0980	0.0000	0.0000

JMB STUDY



JMB STUDY  
 TEST: 3844 DATE: 18 AUG 97 SUBJ: JPAT CELL: C

RELIABILITY FACTORS (IN)

TARGET DESCRIPTION	MAXIMUM	MINIMUM	AVERAGE	STANDARD DEVIATION	AT MAX DISPLACEMENT
1 KNEE	0.2468	0.0014	0.1233	0.0470	0.0980
2 HIP	0.1577	0.0007	0.0394	0.0309	0.0103
3 CHIN	0.1863	0.0263	0.1114	0.0353	0.1464
4 ELBOW	0.0866	0.0005	0.0239	0.0189	0.0449
5 SHOULDER	0.1134	0.0003	0.0407	0.0260	0.0117
6 CHEST	0.1881	0.0022	0.0700	0.0402	0.0612

PREIMPACT POSITION (IN)

TARGET DESCRIPTION	X	Y	Z
1 KNEE	18.0122	-19.5801	7.8018
2 HIP	8.0538	-14.4172	5.8501
3 CHIN	13.3222	-8.0262	30.2831
4 ELBOW	5.8957	-18.4743	10.8673
5 SHOULDER	3.2455	-15.7029	17.7001
6 CHEST	14.7617	-8.1801	24.0773

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
KNEE				
POSITION(IN)				
X AXIS	18.5222	0.4560	17.7416	0.0880
Y AXIS	-19.4661	0.0140	-20.7077	0.1980
Z AXIS	7.8040	0.0080	2.4401	0.2040
VELOCITY(IN/SEC)	99.8416	0.0720	2.1671	0.0000
ACCELERATION(G)	13.0375	0.0880	0.4002	0.3680
DISPLACEMENT(IN)				
X AXIS	0.5100	0.4560	-0.2707	0.0880
Y AXIS	0.1141	0.0140	-1.1276	0.1980
Z AXIS	0.0022	0.0080	-5.3617	0.2040
RESULTANT	5.4708	0.2000	0.0000	0.0000

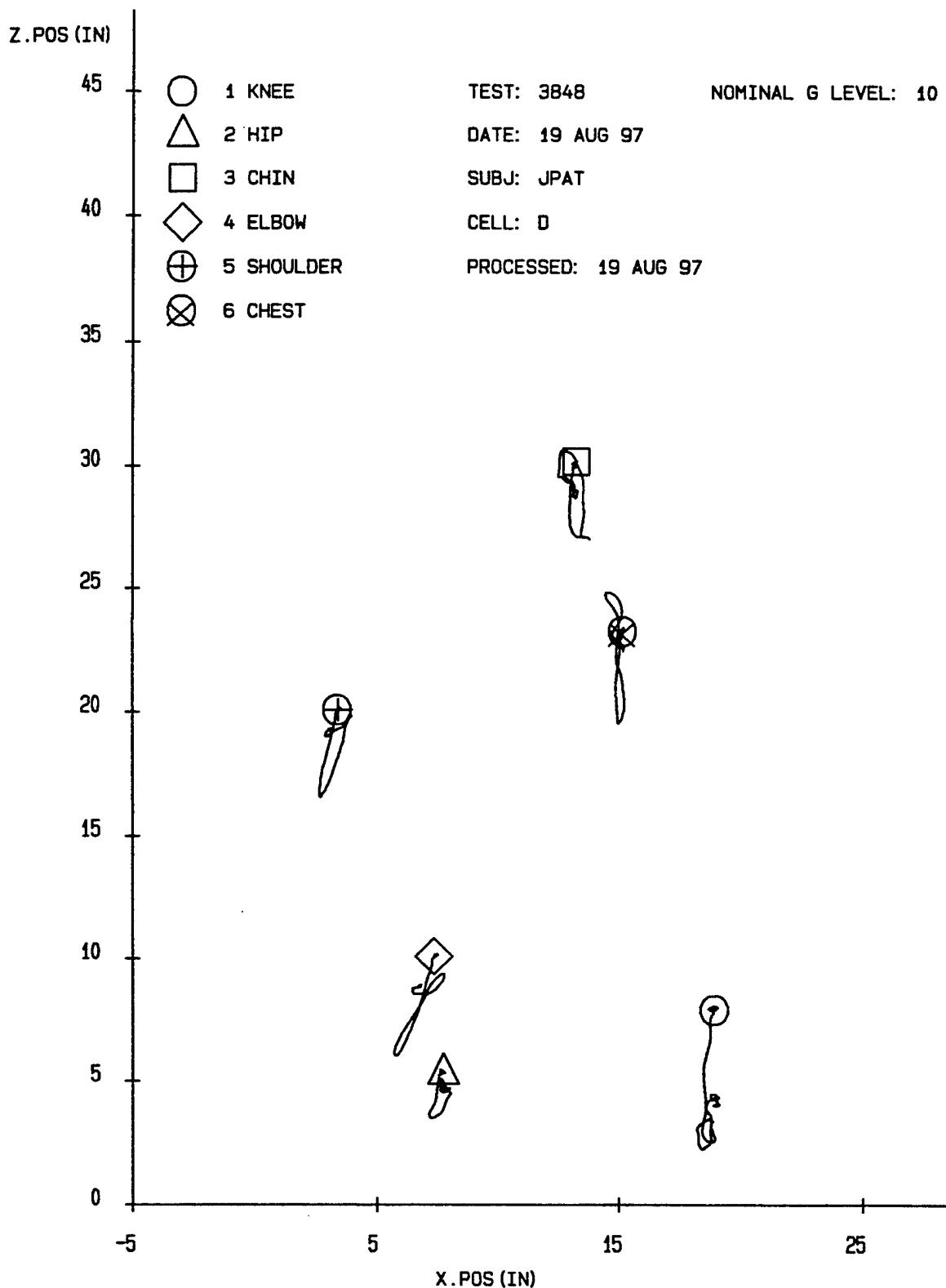
JMB STUDY  
 TEST: 3844 DATE: 18 AUG 97 SUBJ: JPAT CELL: C

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
HIP				
POSITION(IN)				
X AXIS	8.8081	0.1420	7.7039	0.0740
Y AXIS	-14.1278	0.0140	-14.9529	0.1120
Z AXIS	5.8501	0.0000	3.8821	0.0940
VELOCITY(IN/SEC)	50.5234	0.0620	2.1446	0.4040
ACCELERATION(G)	7.1534	0.3560	0.2039	0.0000
DISPLACEMENT(IN)				
X AXIS	0.7542	0.1420	-0.3499	0.0740
Y AXIS	0.2894	0.0140	-0.5356	0.1120
Z AXIS	0.0000	0.0000	-1.9679	0.0940
RESULTANT	1.9726	0.0940	0.0000	0.0000
CHIN				
POSITION(IN)				
X AXIS	14.0470	0.1060	12.5064	0.2560
Y AXIS	-7.9508	0.0080	-9.2759	0.3340
Z AXIS	31.3183	0.2120	26.9482	0.1240
VELOCITY(IN/SEC)	77.3376	0.1580	4.7754	0.3960
ACCELERATION(G)	10.1071	0.1360	0.4488	0.4280
DISPLACEMENT(IN)				
X AXIS	0.7248	0.1060	-0.8158	0.2560
Y AXIS	0.0754	0.0080	-1.2498	0.3340
Z AXIS	1.0351	0.2120	-3.3349	0.1240
RESULTANT	3.4931	0.1200	0.0000	0.0000
ELBOW				
POSITION(IN)				
X AXIS	5.9405	0.0180	4.0457	0.2980
Y AXIS	-17.0447	0.0900	-18.5050	0.0060
Z AXIS	10.8673	0.0000	6.4911	0.0920
VELOCITY(IN/SEC)	108.1098	0.0680	0.5542	0.3960

JMB STUDY  
 TEST: 3844 DATE: 18 AUG 97 SUBJ: JPAT CELL: C

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
ELBOW				
ACCELERATION(G)	17.1313	0.0880	0.2272	0.4120
DISPLACEMENT(IN)				
X AXIS	0.0448	0.0180	-1.8500	0.2980
Y AXIS	1.4296	0.0900	-0.0307	0.0060
Z AXIS	0.0000	0.0000	-4.3762	0.0920
RESULTANT	4.8259	0.0920	0.0000	0.0000
SHOULDER				
POSITION(IN)				
X AXIS	3.3074	0.0200	2.2659	0.3280
Y AXIS	-15.0533	0.0860	-15.9941	0.2040
Z AXIS	17.7081	0.0060	13.7479	0.0920
VELOCITY(IN/SEC)	95.4159	0.0660	1.3192	0.3860
ACCELERATION(G)	14.4566	0.0880	0.2505	0.2340
DISPLACEMENT(IN)				
X AXIS	0.0619	0.0200	-0.9796	0.3280
Y AXIS	0.6495	0.0860	-0.2912	0.2040
Z AXIS	0.0080	0.0060	-3.9522	0.0920
RESULTANT	4.0396	0.0900	0.0000	0.0000
CHEST				
POSITION(IN)				
X AXIS	15.4078	0.1620	14.1839	0.0840
Y AXIS	-7.9787	0.0260	-9.4612	0.3880
Z AXIS	24.3624	0.1880	20.5184	0.0880
VELOCITY(IN/SEC)	98.5899	0.0680	2.4270	0.4260
ACCELERATION(G)	15.5699	0.0860	0.3696	0.3940
DISPLACEMENT(IN)				
X AXIS	0.6461	0.1620	-0.5777	0.0840
Y AXIS	0.2014	0.0260	-1.2812	0.3880
Z AXIS	0.2851	0.1880	-3.5590	0.0880
RESULTANT	3.7058	0.0880	0.0000	0.0000

JMB STUDY



JMB STUDY  
TEST: 3848 DATE: 19 AUG 97 SUBJ: JPAT CELL: D

RELIABILITY FACTORS (IN)					
TARGET DESCRIPTION	MAXIMUM	MINIMUM	AVERAGE	STANDARD DEVIATION	AT MAX DISPLACEMENT
1 KNEE	0.2527	0.0039	0.1167	0.0511	0.1806
2 HIP	0.1486	0.0002	0.0421	0.0347	0.0674
3 CHIN	0.2989	0.0468	0.1541	0.0482	0.1780
4 ELBOW	0.0744	0.0001	0.0312	0.0201	0.0630
5 SHOULDER	0.1138	0.0001	0.0374	0.0267	0.0122
6 CHEST	0.1851	0.0002	0.0810	0.0422	0.1573

PREIMPACT POSITION (IN)			
TARGET DESCRIPTION	X	Y	Z
1 KNEE	18.8294	-20.4863	7.9176
2 HIP	7.7297	-14.4823	5.3162
3 CHIN	13.1606	-8.6845	30.0600
4 ELBOW	7.4177	-18.5185	10.0722
5 SHOULDER	3.3995	-15.2103	20.0824
6 CHEST	15.1529	-8.9806	23.2049

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
KNEE				
POSITION(IN)				
X AXIS	19.1329	0.4420	18.2278	0.1700
Y AXIS	-20.2991	0.1020	-21.3989	0.1580
Z AXIS	7.9176	0.0000	2.2647	0.2040
VELOCITY(IN/SEC)	105.9062	0.0700	5.3612	0.3800
ACCELERATION(G)	14.4769	0.0920	0.7047	0.3700
DISPLACEMENT(IN)				
X AXIS	0.3035	0.4420	-0.6016	0.1700
Y AXIS	0.1872	0.1020	-0.9127	0.1580
Z AXIS	0.0000	0.0000	-5.6529	0.2040
RESULTANT	5.6805	0.2020	0.0000	0.0000

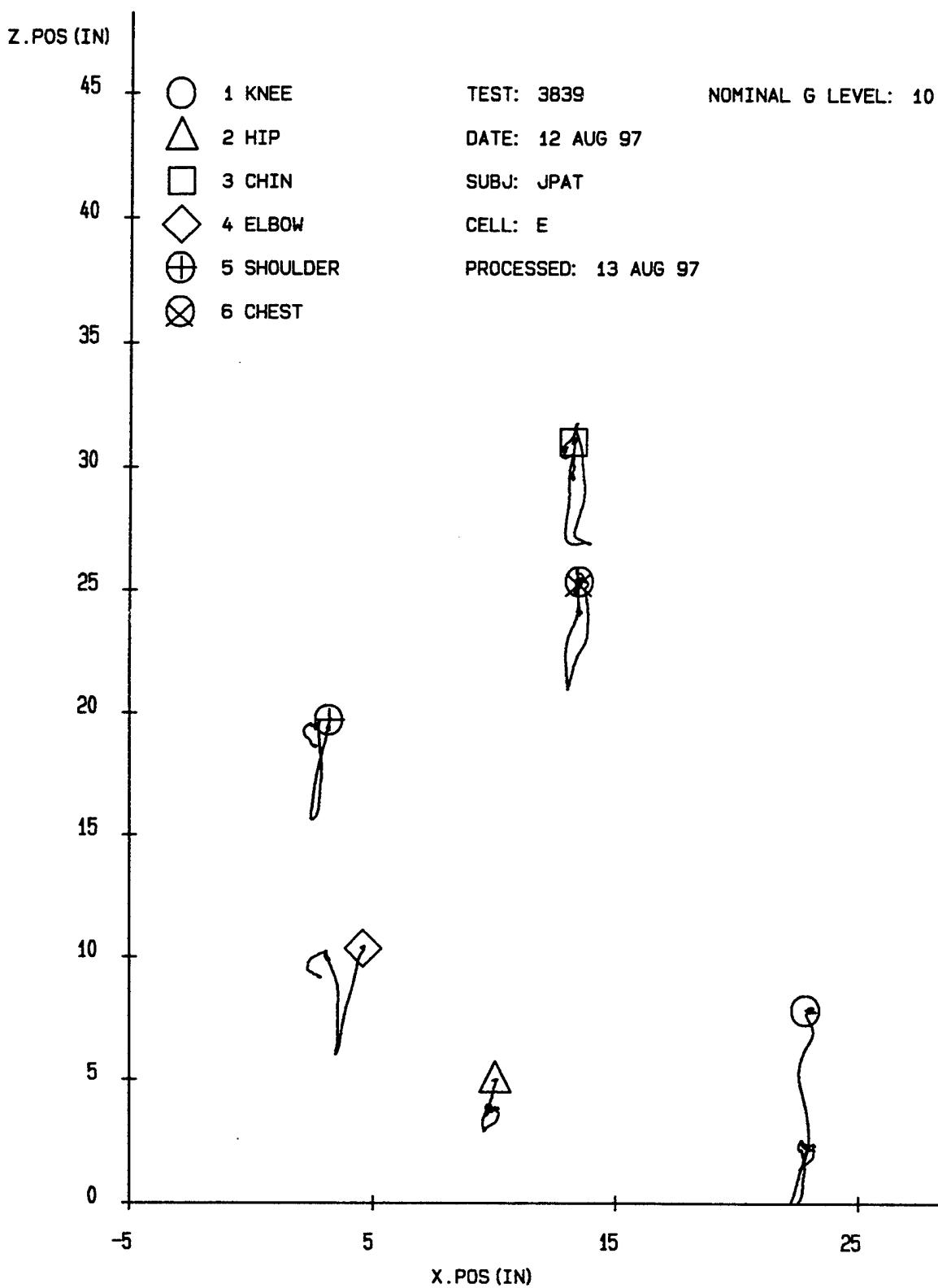
JMB STUDY  
 TEST: 3848 DATE: 19 AUG 97 SUBJ: JPAT CELL: D

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
HIP				
POSITION(IN)				
X AXIS	8.0553	0.1280	7.1617	0.0660
Y AXIS	-13.9151	0.2580	-14.9412	0.4060
Z AXIS	5.3162	0.0000	3.5073	0.0760
VELOCITY(IN/SEC)	58.4135	0.0480	3.3862	0.1820
ACCELERATION(G)	8.8856	0.4020	0.3952	0.2680
DISPLACEMENT(IN)				
X AXIS	0.3255	0.1280	-0.5680	0.0660
Y AXIS	0.5673	0.2580	-0.4589	0.4060
Z AXIS	0.0000	0.0000	-1.8089	0.0760
RESULTANT	1.8666	0.0740	0.0000	0.0000
CHIN				
POSITION(IN)				
X AXIS	13.7515	0.1100	12.4759	0.2520
Y AXIS	-8.3805	0.3480	-9.5238	0.1620
Z AXIS	30.6184	0.2220	27.0045	0.1120
VELOCITY(IN/SEC)	64.5778	0.0580	1.2781	0.1100
ACCELERATION(G)	8.8456	0.2260	0.0760	0.3760
DISPLACEMENT(IN)				
X AXIS	0.5909	0.1100	-0.6847	0.2520
Y AXIS	0.3041	0.3480	-0.8392	0.1620
Z AXIS	0.5584	0.2220	-3.0555	0.1120
RESULTANT	3.2052	0.1120	0.0000	0.0000
ELBOW				
POSITION(IN)				
X AXIS	7.7915	0.1860	5.7153	0.0920
Y AXIS	-17.5447	0.0780	-18.7745	0.0220
Z AXIS	10.0722	0.0000	6.0358	0.0860
VELOCITY(IN/SEC)	110.4538	0.0640	2.1807	0.4200

JMB STUDY  
TEST: 3848 DATE: 19 AUG 97 SUBJ: JPAT CELL: D

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
<b>ELBOW</b>				
ACCELERATION(G)	15.7437	0.0840	0.5251	0.2180
<b>DISPLACEMENT(IN)</b>				
X AXIS	0.3738	0.1860	-1.7024	0.0920
Y AXIS	0.9738	0.0780	-0.2560	0.0220
Z AXIS	0.0000	0.0000	-4.0364	0.0860
RESULTANT	4.4394	0.0860	0.0000	0.0000
<b>SHOULDER</b>				
POSITION(IN)				
X AXIS	3.9149	0.1720	2.6294	0.0780
Y AXIS	-14.9776	0.3640	-15.6590	0.1520
Z AXIS	20.0874	0.0040	16.5619	0.0840
VELOCITY(IN/SEC)	91.2648	0.0600	1.2952	0.3900
ACCELERATION(G)	12.8193	0.0820	0.1646	0.3360
DISPLACEMENT(IN)				
X AXIS	0.5154	0.1720	-0.7701	0.0780
Y AXIS	0.2327	0.3640	-0.4487	0.1520
Z AXIS	0.0051	0.0040	-3.5205	0.0840
RESULTANT	3.6002	0.0840	0.0000	0.0000
<b>CHEST</b>				
POSITION(IN)				
X AXIS	15.2200	0.1040	14.4164	0.1860
Y AXIS	-8.6877	0.3320	-9.9475	0.1500
Z AXIS	24.8135	0.1920	19.5387	0.0860
VELOCITY(IN/SEC)	85.0659	0.0640	1.3321	0.3660
ACCELERATION(G)	14.8578	0.0840	0.3009	0.4300
DISPLACEMENT(IN)				
X AXIS	0.0672	0.1040	-0.7364	0.1860
Y AXIS	0.2928	0.3320	-0.9669	0.1500
Z AXIS	1.6085	0.1920	-3.6662	0.0860
RESULTANT	3.6984	0.0860	0.0000	0.0000

JMB STUDY



JMB STUDY  
TEST: 3839 DATE: 12 AUG 97 SUBJ: JPAT CELL: E

RELIABILITY FACTORS (IN)

TARGET DESCRIPTION	MAXIMUM	MINIMUM	AVERAGE	STANDARD DEVIATION	AT MAX DISPLACEMENT
1 KNEE	0.2625	0.0009	0.1006	0.0590	0.0241
2 HIP	0.1044	0.0002	0.0305	0.0215	0.0520
3 CHIN	0.1483	0.0004	0.0845	0.0364	0.1080
4 ELBOW	0.1055	0.0003	0.0270	0.0226	0.0132
5 SHOULDER	0.1386	0.0025	0.0563	0.0325	0.0129
6 CHEST	0.1590	0.0018	0.0674	0.0381	0.0290

PREIMPACT POSITION (IN)

TARGET DESCRIPTION	X	Y	Z
1 KNEE	23.1772	-16.0566	7.7827
2 HIP	10.0944	-12.1869	4.9312
3 CHIN	13.2322	-6.0601	31.1007
4 ELBOW	4.5882	-15.6769	10.3258
5 SHOULDER	3.2256	-13.2710	19.7422
6 CHEST	13.5097	-5.1362	25.4134

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
KNEE				
POSITION(IN)				
X AXIS	23.2642	0.4580	22.2277	0.2180
Y AXIS	-15.4297	0.4220	-16.7454	0.3300
Z AXIS	7.7900	0.0120	-0.2677	0.2200
VELOCITY(IN/SEC)	156.0530	0.0760	3.4373	0.0040
ACCELERATION(G)	20.8223	0.0920	0.4396	0.4000
DISPLACEMENT(IN)				
X AXIS	0.0869	0.4580	-0.9495	0.2180
Y AXIS	0.6269	0.4220	-0.6888	0.3300
Z AXIS	0.0072	0.0120	-8.0505	0.2200
RESULTANT	8.1057	0.2200	0.0000	0.0000

JMB STUDY  
 TEST: 3839 DATE: 12 AUG 97 SUBJ: JPAT CELL: E

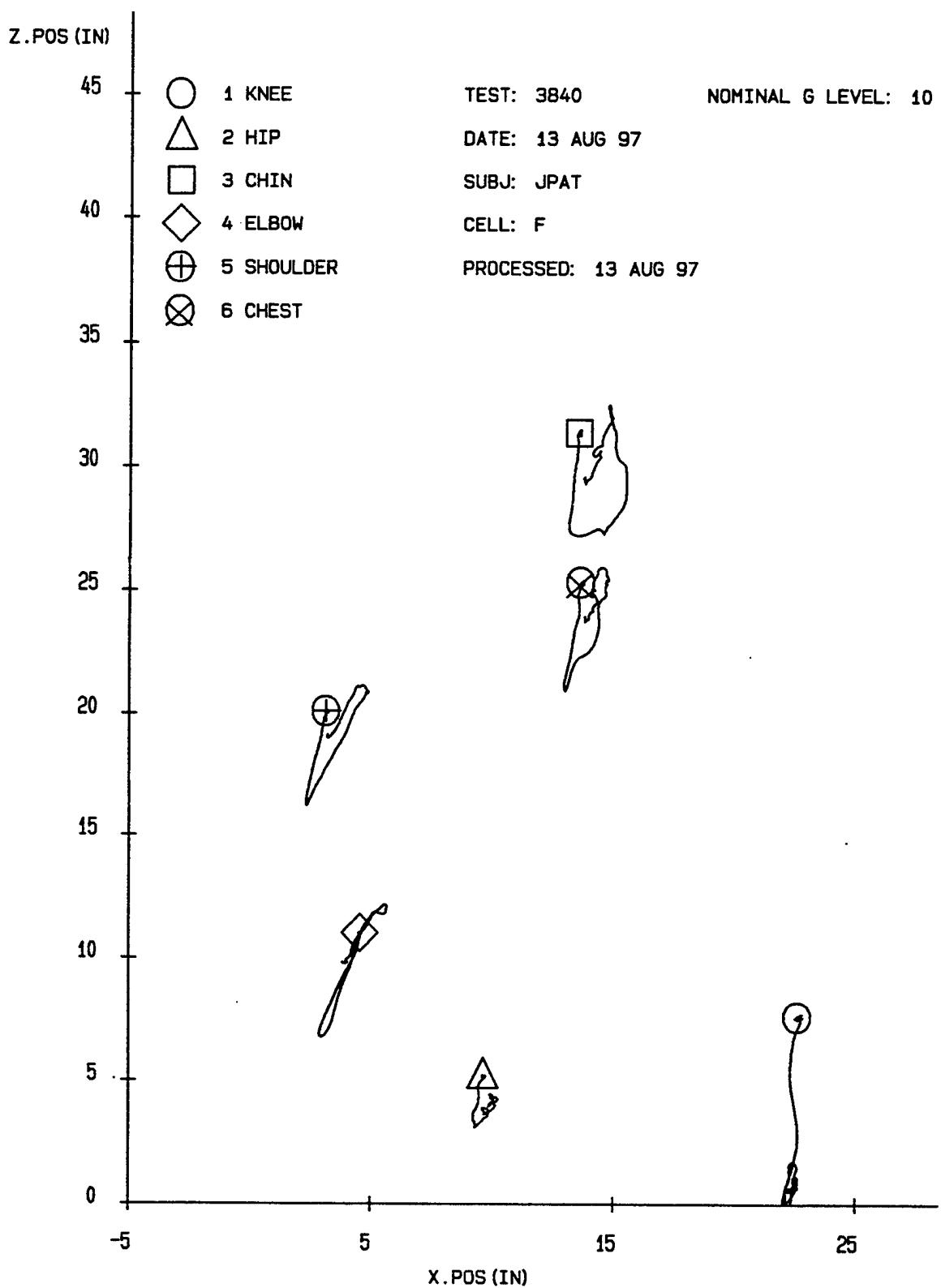
TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
<b>HIP</b>				
POSITION(IN)				
X AXIS	10.1801	0.4420	9.5293	0.0660
Y AXIS	-11.7135	0.2480	-12.6999	0.1020
Z AXIS	4.9482	0.0140	2.9121	0.0840
VELOCITY(IN/SEC)	55.5584	0.0500	1.5609	0.4120
ACCELERATION(G)	8.7567	0.0800	0.2088	0.2640
DISPLACEMENT(IN)				
X AXIS	0.0857	0.4420	-0.5651	0.0660
Y AXIS	0.4734	0.2480	-0.5130	0.1020
Z AXIS	0.0170	0.0140	-2.0191	0.0840
RESULTANT	2.0910	0.0840	0.0000	0.0000
<b>CHIN</b>				
POSITION(IN)				
X AXIS	13.9020	0.1140	12.7025	0.2680
Y AXIS	-5.8874	0.0680	-7.5727	0.1920
Z AXIS	31.7624	0.2220	26.8730	0.1180
VELOCITY(IN/SEC)	94.8405	0.0740	4.2233	0.1140
ACCELERATION(G)	13.0703	0.0860	0.5781	0.3800
DISPLACEMENT(IN)				
X AXIS	0.6698	0.1140	-0.5298	0.2680
Y AXIS	0.1727	0.0680	-1.5125	0.1920
Z AXIS	0.6616	0.2220	-4.2277	0.1180
RESULTANT	4.4023	0.1160	0.0000	0.0000
<b>ELBOW</b>				
POSITION(IN)				
X AXIS	4.6242	0.0120	2.3207	0.3540
Y AXIS	-14.4732	0.0880	-15.7802	0.0220
Z AXIS	10.3259	0.0020	6.0093	0.0900
VELOCITY(IN/SEC)	113.6123	0.0700	3.5963	0.1920

## JMB STUDY

TEST: 3839 DATE: 12 AUG 97 SUBJ: JPAT CELL: E

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
ELBOW				
ACCELERATION(G)	17.9741	0.0880	0.4791	0.2720
DISPLACEMENT(IN)				
X AXIS	0.0360	0.0120	-2.2675	0.3540
Y AXIS	1.2038	0.0880	-0.1033	0.0220
Z AXIS	0.0000	0.0020	-4.3165	0.0900
RESULTANT	4.6127	0.0900	0.0000	0.0000
SHOULDER				
POSITION(IN)				
X AXIS	3.2393	0.0080	2.1617	0.3360
Y AXIS	-12.8386	0.0860	-13.8642	0.1600
Z AXIS	19.7797	0.0060	15.6075	0.0920
VELOCITY(IN/SEC)	100.3379	0.0700	1.4377	0.4540
ACCELERATION(G)	16.1569	0.0880	0.3786	0.3620
DISPLACEMENT(IN)				
X AXIS	0.0137	0.0080	-1.0639	0.3360
Y AXIS	0.4324	0.0860	-0.5932	0.1600
Z AXIS	0.0375	0.0060	-4.1347	0.0920
RESULTANT	4.2159	0.0900	0.0000	0.0000
CHEST				
POSITION(IN)				
X AXIS	13.8141	0.1480	12.9046	0.0720
Y AXIS	-4.9115	0.0080	-6.5818	0.2160
Z AXIS	25.8860	0.2580	20.9548	0.0920
VELOCITY(IN/SEC)	101.2174	0.0740	2.2714	0.0080
ACCELERATION(G)	19.1190	0.0900	0.1800	0.3720
DISPLACEMENT(IN)				
X AXIS	0.3044	0.1480	-0.6051	0.0720
Y AXIS	0.2248	0.0080	-1.4455	0.2160
Z AXIS	0.4726	0.2580	-4.4586	0.0920
RESULTANT	4.5174	0.0920	0.0000	0.0000

JMB STUDY



JMB STUDY  
TEST: 3840 DATE: 13 AUG 97 SUBJ: JPAT CELL: F

RELIABILITY FACTORS (IN)

TARGET DESCRIPTION	MAXIMUM	MINIMUM	AVERAGE	STANDARD DEVIATION	AT MAX DISPLACEMENT
1 KNEE	0.3694	0.0003	0.1099	0.0770	0.0032
2 HIP	0.1160	0.0001	0.0318	0.0241	0.0189
3 CHIN	0.2193	0.0375	0.1419	0.0368	0.1735
4 ELBOW	0.0681	0.0003	0.0223	0.0178	0.0544
5 SHOULDER	0.1178	0.0013	0.0468	0.0290	0.0302
6 CHEST	0.1528	0.0017	0.0656	0.0360	0.0455

PREIMPACT POSITION (IN)

TARGET DESCRIPTION	X	Y	Z
1 KNEE	22.7426	-16.5329	7.6023
2 HIP	9.6629	-12.6416	5.1496
3 CHIN	13.5643	-6.3753	31.2777
4 ELBOW	4.6229	-15.7963	11.0212
5 SHOULDER	3.1793	-13.3939	20.0481
6 CHEST	13.6252	-5.7155	25.2361

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
KNEE				
POSITION(IN)				
X AXIS	22.7426	0.0000	21.6203	0.2140
Y AXIS	-14.9927	0.2940	-17.4018	0.1880
Z AXIS	7.6523	0.0080	-1.5103	0.2280
VELOCITY(IN/SEC)	164.3786	0.0840	4.3946	0.3180
ACCELERATION(G)	24.6348	0.0980	0.3599	0.4560
DISPLACEMENT(IN)				
X AXIS	0.0000	0.0000	-1.1223	0.2140
Y AXIS	1.5402	0.2940	-0.8689	0.1880
Z AXIS	0.0500	0.0080	-9.1125	0.2280
RESULTANT	9.2116	0.2300	0.0000	0.0000

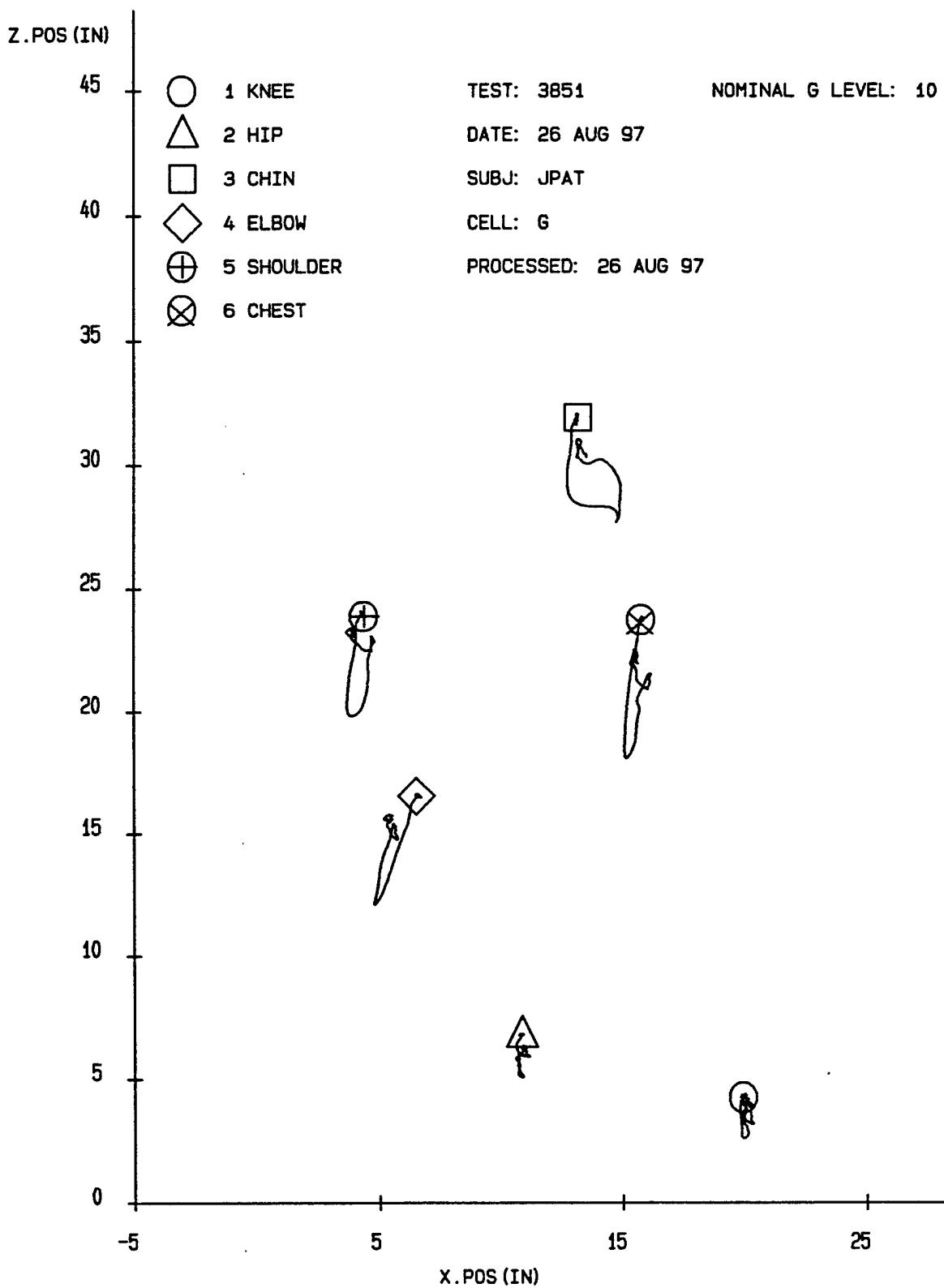
JMB STUDY  
 TEST: 3840 DATE: 13 AUG 97 SUBJ: JPAT CELL: F

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
HIP				
POSITION(IN)				
X AXIS	10.2624	0.2740	9.2428	0.0640
Y AXIS	-12.3284	0.3880	-13.1188	0.2520
Z AXIS	5.1564	0.0080	3.1312	0.0900
VELOCITY(IN/SEC)	48.0479	0.0440	1.7673	0.3160
ACCELERATION(G)	7.0487	0.2560	0.1848	0.0460
DISPLACEMENT(IN)				
X AXIS	0.5994	0.2740	-0.4201	0.0640
Y AXIS	0.3133	0.3880	-0.4772	0.2520
Z AXIS	0.0068	0.0080	-2.0184	0.0900
RESULTANT	2.0521	0.0900	0.0000	0.0000
CHIN				
POSITION(IN)				
X AXIS	15.4245	0.1920	13.0793	0.0800
Y AXIS	-4.8803	0.3300	-7.2377	0.1220
Z AXIS	32.5083	0.2760	27.2159	0.0940
VELOCITY(IN/SEC)	90.0865	0.0680	4.2180	0.0000
ACCELERATION(G)	14.3384	0.0840	0.5749	0.3960
DISPLACEMENT(IN)				
X AXIS	1.8602	0.1920	-0.4850	0.0800
Y AXIS	1.4950	0.3300	-0.8624	0.1220
Z AXIS	1.2306	0.2760	-4.0618	0.0940
RESULTANT	4.1612	0.1280	0.0000	0.0000
ELBOW				
POSITION(IN)				
X AXIS	5.6581	0.2720	2.8628	0.0980
Y AXIS	-14.1482	0.0920	-17.1147	0.1820
Z AXIS	12.1459	0.2860	6.7788	0.0920
VELOCITY(IN/SEC)	112.1120	0.1120	5.7184	0.4560

JMB STUDY  
TEST: 3840 DATE: 13 AUG 97 SUBJ: JPAT CELL: F

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
ELBOW				
ACCELERATION(G)	21.6202	0.0920	0.3407	0.2140
DISPLACEMENT(IN)				
X AXIS	1.0353	0.2720	-1.7601	0.0980
Y AXIS	1.6481	0.0920	-1.3184	0.1820
Z AXIS	1.1247	0.2860	-4.2424	0.0920
RESULTANT	4.8559	0.0920	0.0000	0.0000
SHOULDER				
POSITION(IN)				
X AXIS	4.8818	0.2400	2.2853	0.0860
Y AXIS	-12.6529	0.0840	-14.0769	0.1720
Z AXIS	21.1331	0.2760	16.1870	0.0920
VELOCITY(IN/SEC)	100.0754	0.0680	0.4050	0.4180
ACCELERATION(G)	16.7429	0.0900	0.6012	0.4300
DISPLACEMENT(IN)				
X AXIS	1.7025	0.2400	-0.8940	0.0860
Y AXIS	0.7410	0.0840	-0.6830	0.1720
Z AXIS	1.0850	0.2760	-3.8611	0.0920
RESULTANT	4.0080	0.0920	0.0000	0.0000
CHEST				
POSITION(IN)				
X AXIS	14.7291	0.2400	12.9170	0.0880
Y AXIS	-4.1505	0.2880	-6.0455	0.1200
Z AXIS	25.9154	0.2780	20.9339	0.0940
VELOCITY(IN/SEC)	94.5052	0.0740	5.0917	0.2020
ACCELERATION(G)	18.0255	0.0900	0.5385	0.3820
DISPLACEMENT(IN)				
X AXIS	1.1040	0.2400	-0.7082	0.0880
Y AXIS	1.5650	0.2880	-0.3300	0.1200
Z AXIS	0.6793	0.2780	-4.3022	0.0940
RESULTANT	4.3550	0.0940	0.0000	0.0000

JMB STUDY



JMB STUDY  
TEST: 3851 DATE: 26 AUG 97 SUBJ: JPAT CELL: G

RELIABILITY FACTORS (IN)

TARGET DESCRIPTION	MAXIMUM	MINIMUM	AVERAGE	STANDARD DEVIATION	AT MAX DISPLACEMENT
1 KNEE	0.2093	0.0002	0.0628	0.0451	0.0139
2 HIP	0.1000	0.0001	0.0373	0.0247	0.0517
3 CHIN	0.2082	0.0119	0.1091	0.0468	0.1465
4 ELBOW	0.0904	0.0002	0.0400	0.0236	0.0021
5 SHOULDER	0.1244	0.0001	0.0397	0.0258	0.0621
6 CHEST	0.2069	0.0001	0.0795	0.0469	0.1127

PREIMPACT POSITION (IN)

TARGET DESCRIPTION	X	Y	Z
1 KNEE	20.0366	-16.9941	4.2783
2 HIP	10.8807	-14.0452	6.8034
3 CHIN	13.1917	-6.5535	32.0462
4 ELBOW	6.6198	-15.9920	16.5965
5 SHOULDER	4.2541	-13.3538	24.0557
6 CHEST	15.8339	-7.5852	23.8243

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
KNEE				
POSITION(IN)				
X AXIS	20.3546	0.2100	19.8001	0.0340
Y AXIS	-16.6187	0.2700	-17.4961	0.1200
Z AXIS	4.2783	0.0000	2.5976	0.0680
VELOCITY(IN/SEC)	49.8854	0.0480	3.0142	0.4000
ACCELERATION(G)	8.6433	0.0640	0.5368	0.3540
DISPLACEMENT(IN)				
X AXIS	0.3181	0.2100	-0.2365	0.0340
Y AXIS	0.3754	0.2700	-0.5020	0.1200
Z AXIS	0.0000	0.0000	-1.6807	0.0680
RESULTANT	1.6820	0.0680	0.0000	0.0000

JMB STUDY  
TEST: 3851 DATE: 26 AUG 97 SUBJ: JPAT CELL: G

TARGET	MAXIMUM	TIME(SEC)	MINIMUM	TIME(SEC)
HIP				
POSITION(IN)				
X AXIS	11.2171	0.2100	10.6712	0.1300
Y AXIS	-13.9069	0.0440	-14.6506	0.1200
Z AXIS	6.8034	0.0000	5.0612	0.0820
VELOCITY(IN/SEC)	50.7660	0.0540	0.8176	0.3660
ACCELERATION(G)	8.5898	0.0880	0.3592	0.3880
DISPLACEMENT(IN)				
X AXIS	0.3363	0.2100	-0.2096	0.1300
Y AXIS	0.1383	0.0440	-0.6054	0.1200
Z AXIS	0.0000	0.0000	-1.7422	0.0820
RESULTANT	1.7466	0.0820	0.0000	0.0000
CHIN				
POSITION(IN)				
X AXIS	14.9413	0.2000	12.7806	0.0660
Y AXIS	-5.8231	0.3120	-7.8528	0.1100
Z AXIS	32.0462	0.0000	27.7016	0.1520
VELOCITY(IN/SEC)	93.7782	0.0580	5.8770	0.0000
ACCELERATION(G)	10.2326	0.0780	0.7222	0.4160
DISPLACEMENT(IN)				
X AXIS	1.7496	0.2000	-0.4111	0.0660
Y AXIS	0.7304	0.3120	-1.2994	0.1100
Z AXIS	0.0000	0.0000	-4.3446	0.1520
RESULTANT	4.6820	0.1500	0.0000	0.0000
ELBOW				
POSITION(IN)				
X AXIS	6.6533	0.0120	4.7976	0.0960
Y AXIS	-15.5157	0.2700	-16.7031	0.1840
Z AXIS	16.6080	0.0100	12.1119	0.0920
VELOCITY(IN/SEC)	115.8242	0.0660	1.3297	0.0080